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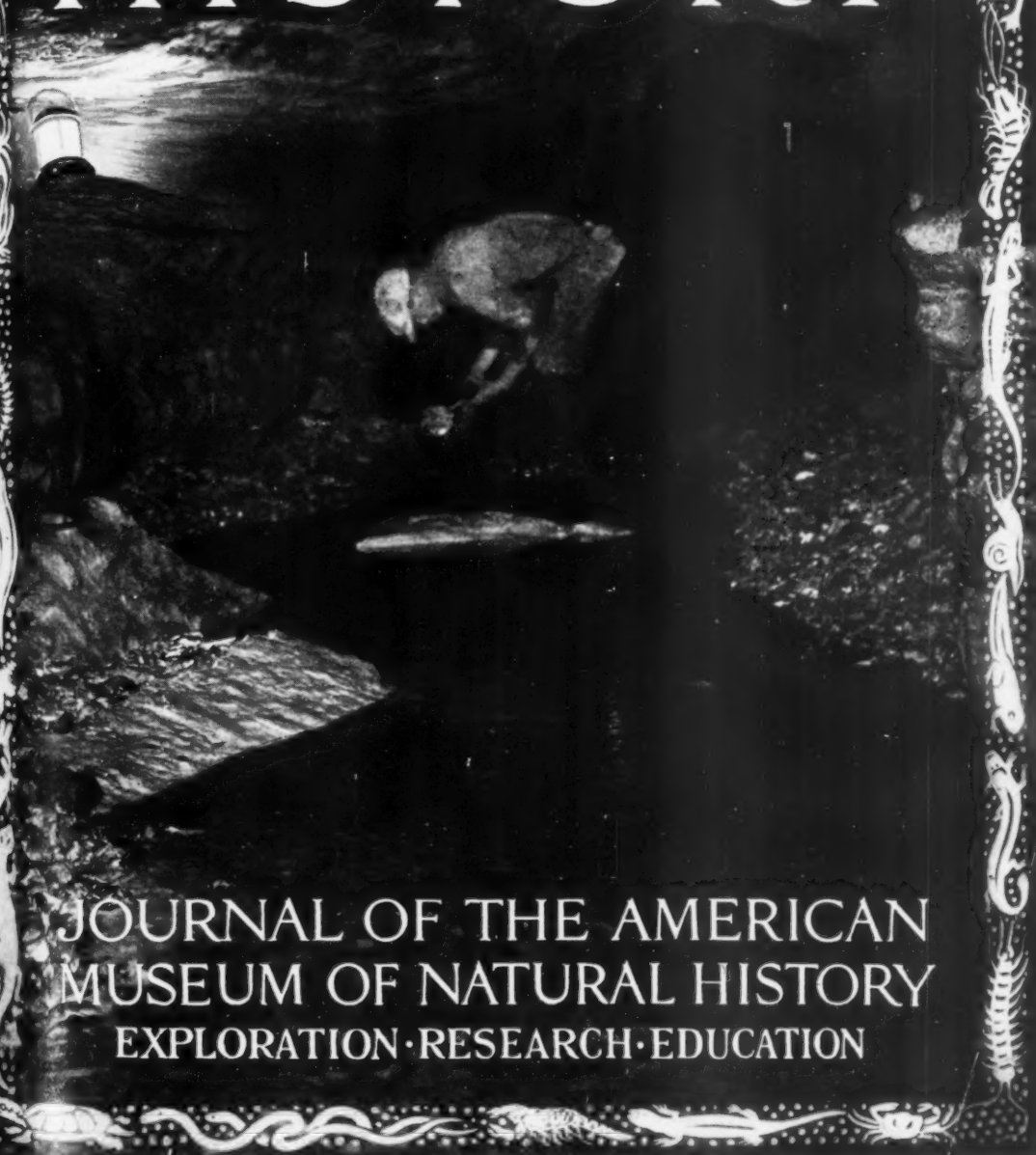
NATURAL HISTORY



JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

EXPLORATION·RESEARCH·EDUCATION

PERIODICAL ROOM

THE AMERICAN MUSEUM OF NATURAL HISTORY

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NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM

DEVOTED TO NATURAL HISTORY
EXPLORATION, AND THE DEVELOPMENT OF PUBLIC EDUCATION
THROUGH THE MUSEUM

GENERAL NUMBER

A. KATHERINE BERGER, EDITOR

SEPTEMBER-OCTOBER, 1927

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Photograph by G. Kingsley Noble

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THE BLIND SALAMANDER

The subterranean passageways of the Ozark Mountains form the habitat of *Typhlotriton spelaeus*. An expedition was sent last September by the American Museum to study this creature in its native haunts. The field work is being supplemented by laboratory experiments to determine the causes of retrogressive evolution in cave animals and particularly in the blind salamander

NATURAL HISTORY

VOLUME XXVII SEPTEMBER-OCTOBER, 1927 NUMBER 5

Creatures of Perpetual Night

AN ACCOUNT OF THE AMERICAN MUSEUM'S EXPEDITION TO THE CAVES OF THE OZARKS IN SEARCH OF THE BLIND SALAMANDER

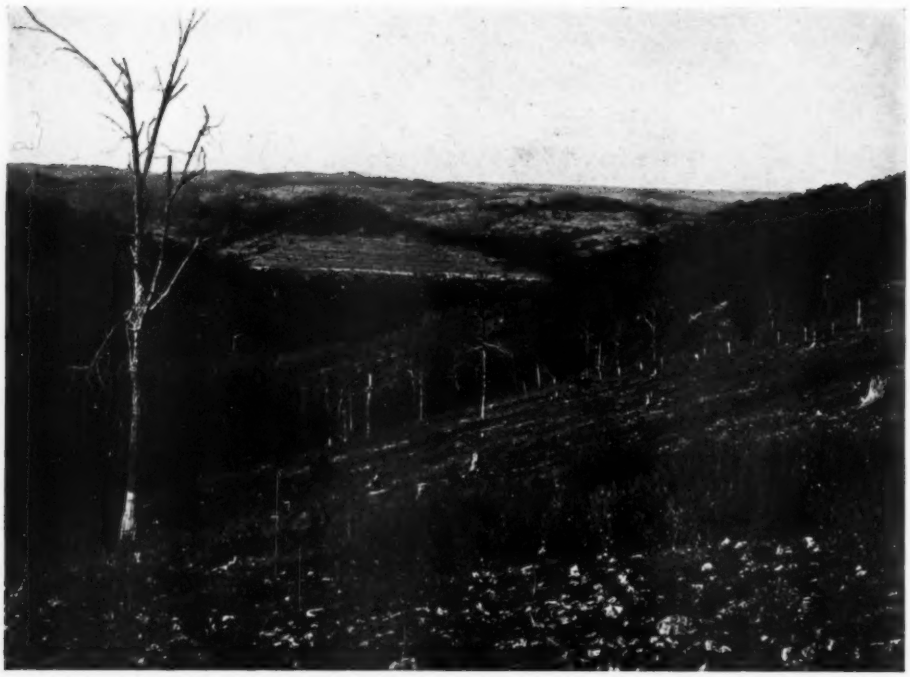
By G. KINGSLEY NOBLE

Curator, Amphibians and Reptiles, American Museum

FROM the Appalachians to the Rockies the vast plains of the continental interior extend some 1200 miles, the thick layers of sediment nearly as even and unwrinkled as when first laid down. From Carboniferous time when the beds of the Mississippi Valley were finally raised above the level of the shallow inland sea until today the great basin which forms so large a part of the United States has remained a lowland, now rising, now sinking, but never oscillating far in either direction. Only in the Ozark region have orogenic forces pushed up the beds of Palæozoic limestone into steep, rocky hills. Limestone is poor material with which to build great mountains. The rains soon smooth off all prominent features, and the water, acidified by the decaying vegetation of the slopes, seeps through the porous rock to carve for itself innumerable channels and chambers within the heart of the hills. The Ozarks, seamed and wrinkled, remain throughout most of the year a series of dry shells within which the subterranean waters flow for miles before bursting forth at the base of the hills to join the larger rivers of the lowlands.

The devious passageways and water channels which honeycomb the Ozarks have always held a strange fascination for the hardy peoples who settled in southern Missouri and northern Arkansas. The more accessible caves, especially those rich in stalactites and stalagmites, were soon explored but there remained dozens of other more extensive caves which seemed to defy the entrance of man. Yet into these crooked, winding passageways adventurers finally penetrated, and we now know that the heart of the Ozarks is not formed merely of cold, stony, dripping chambers. An abundance of life is present and this life is adapted, we may say finds greatest satisfaction, in the inky blackness and perpetual coldness of this subterranean world.

One may well ask why any animal should prefer to live so far removed from the outer world. Naturalists for a century have asked this very question. And some of the most distinguished among them, such as E. D. Cope, have visited the Ozarks to gain a better acquaintance with the cave fauna. Most cave animals are blind, their bodies white and ghostly translucent in the light of a torch. Many are equipped with a rich growth of sense papillæ, or bristles, with which they feel instead of see approaching enemies and prey. What have been the causes of these changes? Use and disuse, the older naturalists replied, but such an explanation does not receive any support from the vast amount of experimental data provided by modern biology. Hence, it seemed advisable to penetrate once more into the Ozark caves to determine more accurately the



View east of Marvel Cave. The Ozark Mountains are a series of hollow shells within which flow most of of the streams of the region

Most cave entrances in the Ozarks are small and hidden. Wild Cat Cave in Barry County is no exception

The Ozarks are formed almost entirely of limestone. Cave entrances are found usually at the foot of the hills

The beginning of a cave. Water flowing over the soft limestone soon cuts a channel for itself and sinks out of sight

environmental factors and further to secure living material in sufficient quantity for an experimental analysis.

The work was carried on in three counties in southwestern Missouri. Toward the end of the trip the latter part of September of this year, our efforts were concentrated on the caves of Stone County, for [here, principally in Marvel Cave, Cope, Eigenmann, and Hurter had found the cave salamander, *Typhlotriton spelaeus*, in some numbers.

Most of the cave entrances in this country are far off the main highway, usually at the foot of some hill. As the roads generally follow the ridges, there was ample opportunity to get acquainted with the fauna of the outer world. The hills on closer acquaintance proved to be steep piles of small limestone chips among which there struggled a thick growth of deciduous woods. Descending a slope was like walking down a coal pile, the chips giving way at every step. In such a terrain devoid of anything that can be called soil, moisture can remain but a short time, and as September had been a very dry month, the loose stones noisily announced our approach with a metallic clatter. The first to be frightened by the intruders was a blue-tailed skink which scurried away in the brush. Turning over adjacent logs we captured two others. This lizard and its close relative, the coal skink, we met very frequently in the hills. The slim-bodied skink, *Leiolopisma*, was found in the same situations and on the more exposed slopes we caught the collared lizard *Crotaphytus collaris*. Our first descent into the lowlands revealed that snakes were far more abundant than in any other place I have visited. The most conspicuous was the mountain black snake, *Elaphe obsoleta*, but the individuals we met were not like our New Jersey friends; they were flecked above with white and blotched below with black. Here was an incipient species not yet sufficiently demarcated from its eastern relatives to be called a distinct race. On these arid slopes a dark coloration would seem entirely out of place, but all the racers, *Coluber flagellum*, we saw, were handsomely clothed in satiny black. Copperheads, we soon discovered, were very common, and after we had captured our first, a few feet from the trail, the almost perfect concealing coloration of this serpent assumed for us a new interest.

Only a very small part of the Ozark fauna seemed concealingly colored and a few creatures were obviously the reverse. One that thrust itself upon us from the first was that of the noisy "news bee," a fly which is colored exactly like a queen yellow jacket and has the form, color, and sound of the same unpleasant acquaintance. Here was an instance of mimicry, the fly supposedly gaining protection by this mummery. Natural selection working

A frightened blue-tailed skink dashed away among the chips of limestone

on a host of color varieties in an ancestral fly picked out this noisy yellow and black fellow, recognizing by this very act that bluff and noise will sometimes carry one a long way toward success.

The entrance to Marvel Cave, called Marble Cave until recently, is through one of two openings in the roof of an enormous subterranean chamber nearly 200 feet high, 400 feet long, and 225 feet wide. A pile of stone débris forms a hill about 125 feet high under the openings and the descent to its summit is managed by a wooden stairway. The latter is maintained by Miss Genevieve Lynch, the owner of the cave, who for some years has opened the cave to visitors. The few tourists who come to this little-known region follow a guide to the far end of the chamber where a tortuous passageway twists back and forth digging deep into the ground until it reaches the water course made by Lost River. The lowest point of the journey is reached at the foot of the waterfall which has been determined as 480 feet below the surface of the ground. Throughout the long route followed by tourists, blind salamanders have never in recent years, been seen. It was our plan to begin where the tourist turns back, namely, at the foot of the waterfall. A hole half way up a bank of soft red clay indicates the opening of the passageway to Blondie's Throne.

Previous experience had taught us that cave exploration is very wet, sticky work. One crawls or wallows forward in adhesive mud far more often than one ever stands. Our party consisted of Byron C. Marshall, a herpetologist of Arkansas, Clark Gallaher, head guide of Marvel Cave, and myself. The bank proved as soft as it looked, and we were all smeared with mud before we reached the entrance and began the long crawl. Marshall and I were armed with electric torches and collecting tins, while Gallaher managed a gasoline lantern, the first, no doubt, ever carried in this narrow passage.

Blondie's Throne is probably not more than four hundred feet from the waterfall, but as much of the distance is covered flat on one's stomach, the trip required over an hour. The passageway probably averages two feet high and four broad. The mud of the water-

Copperheads are abundant in the Ozarks

fall room soon gives way to sheets of limestone and dripstone of varying colors from black to yellow. The floor of the passage is made anything but comfortable by a series of more or less connected pools containing water of 58° F. We dragged ourselves slowly

Our work began where tourists turn back. The first "crawl" in Rockhouse Cave

through the water and found that Hurter, who many years before made this crawl, must have been mistaken as to the scarcity of life. A black gnat which we had seen in other caves was here in abundance, some black beetles were seen walking over the rocks, while the pools contained a colorless amphipod crustacean in numbers.

We came upon our first *Typhlotriton* shortly after beginning the crawl. It was walking rapidly over the loose stones in an effort to escape. In the light of the gasoline lantern its pale tones gave it a most unreal appearance. The beast looked more like some creature fashioned out of dough than a living organism. Its dark eyeballs shone through the translucent lids and gave it a peculiar expression. But once the creature was in the collecting tin it appeared more animate. Close scrutiny revealed that its skin was not devoid of pigment. The net of capillaries underlying the epidermis was covered with melanophores, but these pigment cells were fully contracted. The creature reminded me of the salamanders whose pituitaries I had removed in the laboratory, and I could not help but wonder if the pituitary body was functioning normally in this creature.

We reached Blondie's Throne without encountering any other salamanders. But the bats which dashed past us as we crawled frequently misjudged the distances and rudely brushed us with their wings. Blondie's proved to be a great vault of gray dripstone. A crawl of ten feet up a bank of slippery clay brought us to the main entrance to the room. The ceiling some forty feet overhead seemed to swirl about in the bright gleam of our spot lights. The squeaking and the continuous rain of excrement disclosed that the ceiling was in fact in motion. Myriads of bats circled about overhead, the beating of their wings sounding like the rythmic puffing of a distant locomotive. The room is partly filled by a tremendous stalagmite or throne above which a canopy of stalactites gracefully droops. But the festoons of black drapery on either side of the throne soon began to flutter, and I realized that they were great masses of bats holding tightly to one another's backs. A closer inspection showed that thick rugs at the foot of the throne were sheets of reeking bat guano in which one sank half way to the knee. The odor was stifling, the noise bewildering, and yet the grandeur and

In the Underground Home of the Blind Salamander

GLIMPSES OF THE PASSAGEWAYS WHICH HONEYCOMB THE OZARK MOUNTAINS AND SOME PORTRAITS OF THE CREATURES WHICH DWELL IN THE SUBTERRANEAN WORLD

By G. KINGSLEY NOBLE

Curator, Amphibians and Reptiles, American Museum

CAPTURED BUT STILL DEFIANT

The great-eared bat *Corynorhinus rafinesquii* is the rarest of the four species which inhabit the Ozark caves. This fellow tried to dash by us in a narrow passageway but misjudged the distance. The figure is about twice natural size

ENTRANCE TO MARVEL CAVE

The descent into the best known cave inhabited by the blind salamander is made through the roof of an enormous underground chamber nearly 200 feet in height and 400 feet in length. Directly under the two small openings in the roof is a hill of stone débris more than 100 feet high. Reaching down to the top of this hill, a ladder and stairway have been built. These served as the starting point for many trips to the

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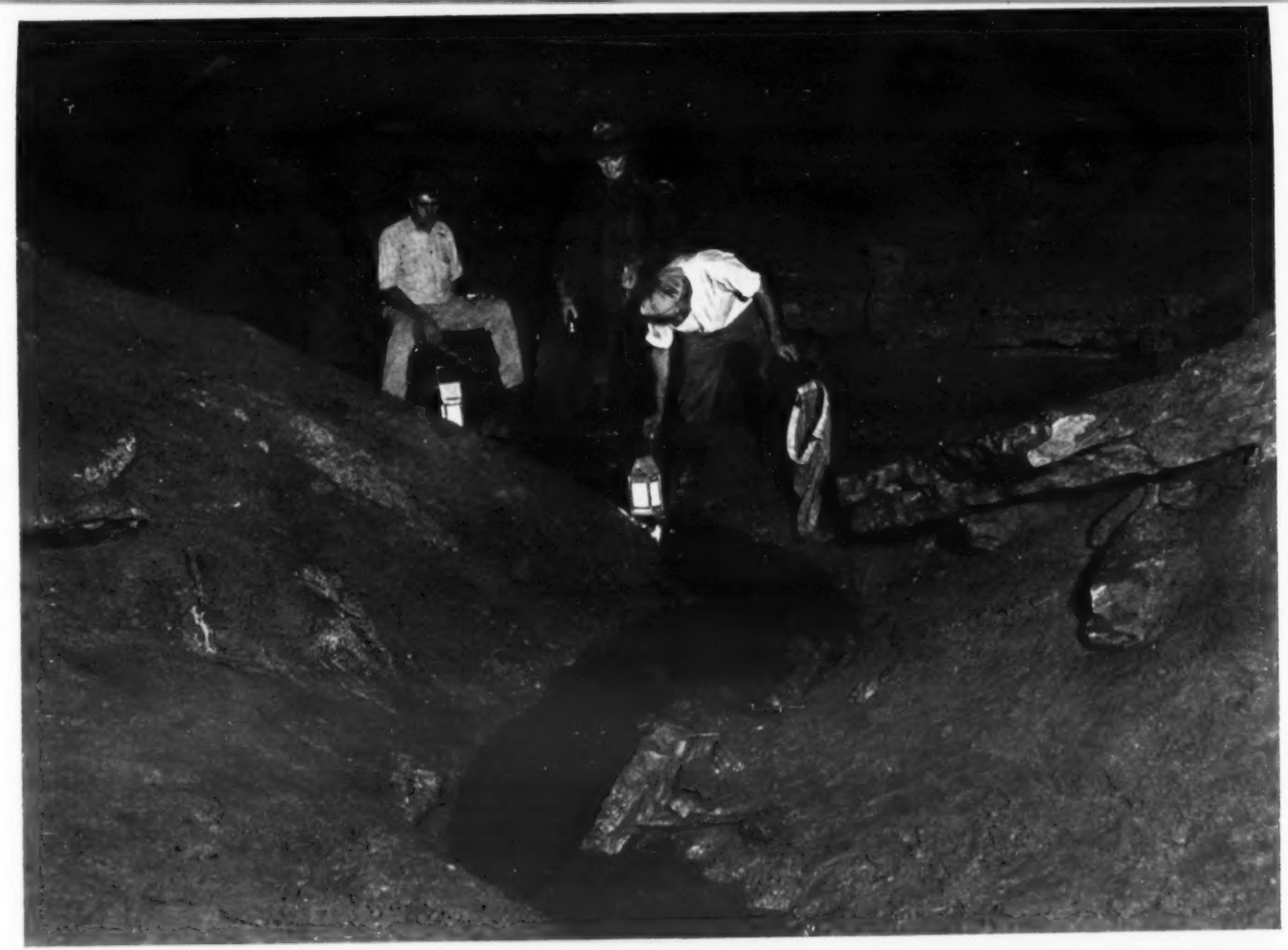


CATCHING A "GRAY GHOST"

The blind salamander, dubbed by earlier explorers the "gray ghost," frequents the edges of small underground streams or pools. The species seemed to have a variety of tastes, for the expedition surprised one on the clay banks of Chimney Cave, shown above, and caught others along the rocky passage of Mystic River in Marvel Cave. Unlike blind salamanders in other parts of the world, the "gray ghost" is primarily terrestrial when full grown

THE WORK OF WATER

Underground water channels penetrate the Ozarks in every direction. Exploring these tunnels is full of uncertainty because of the erratic course taken by the streams. One loses all sense of distance when crawling underground, and we reckoned our travels in hours from daylight.

Underground water channels penetrate the Ozarks in every direction. Exploring these tunnels is full of uncertainty because of the erratic course taken by the streams. One loses all sense of distance when crawling underground, and we reckoned our travels in hours from daylight.

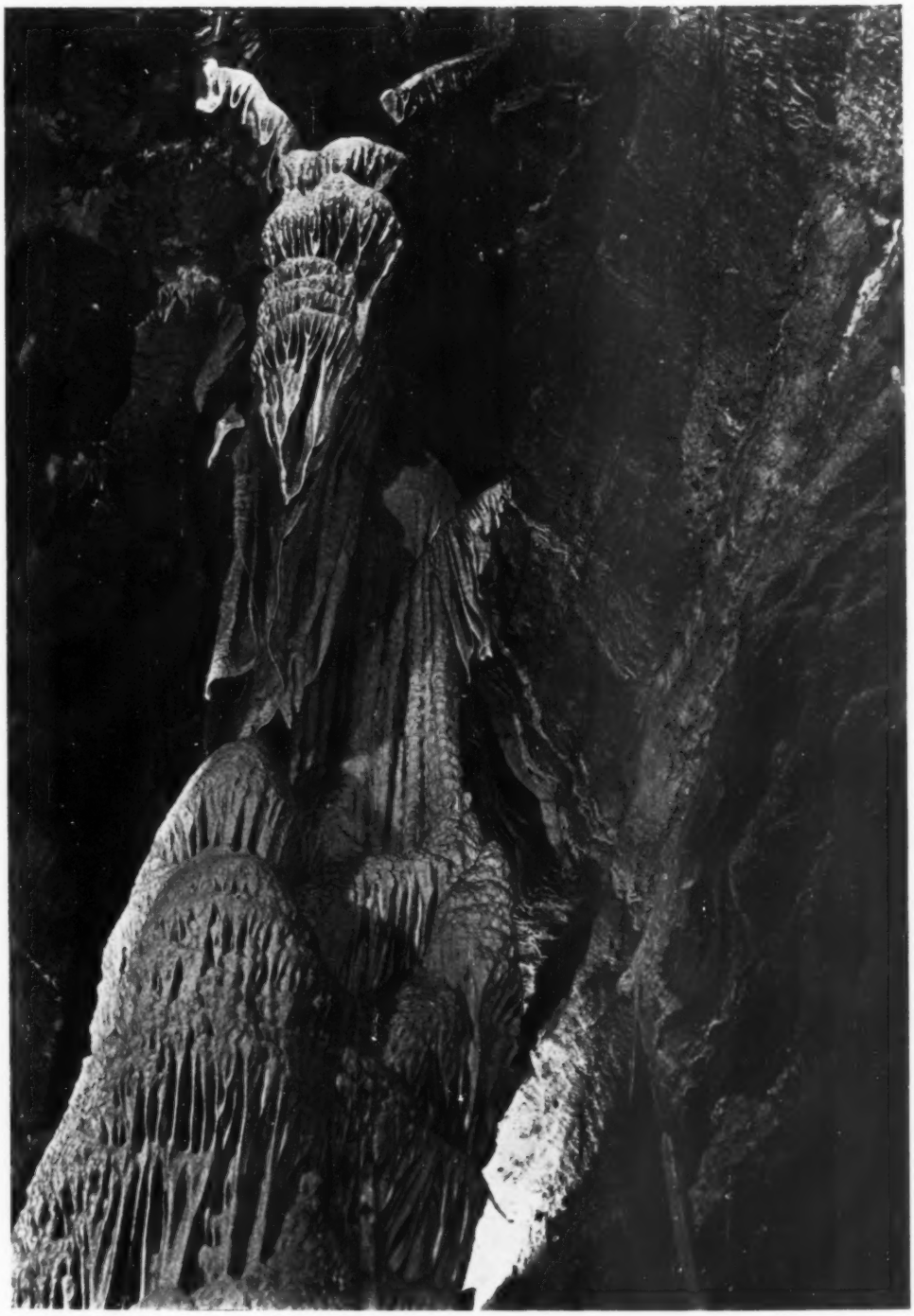
A REST BETWEEN CRAWLS

Most of the passageways are very narrow and the only way of going from one pool to another is by crawling. The passageways are frequently covered with stalactite formations of which the most disconcerting are the hollow spikes of stone hanging from the ceilings of the more difficult "squeezes"

CHAINS OF STONE

The walls of the large underground chamber of Mead's Cave are covered with great sheets of stalactites, some of most unusual form. It is here only that the expedition found a veritable chain of stone hanging from the top of one of the larger "thrones."

Mead's Cave, like many of the other enchanting subterranean chambers of Missouri is unknown to the tourist



THE "ANGEL"

Stalactites are usually terra cotta in color. Only rarely do they appear without a coat of wet, reddish mud. Then these draperies of stone may appear almost any color, especially the softer tones of yellow and red. In Fairy Cave an exquisite stalactite of sparkling white hovers gracefully over an equally beautiful stalagmite. The formation resembles an angel with outspread wings descending a marble throne. Many travelers come each year to see the "Angel" of Fairy Cave

STARING WITH SIGHTLESS EYES

The blind crayfish *Cambarus setosus* is the color of bleached bone. Its eyes are rudimentary, but like all other subterranean animals its sense of touch is greatly refined. Many a young blind salamander has had its tail snipped off by the strong pincers of these crayfishes. The long hairs on the claws are sensory organs and are not found in the species which live in the outer world, for the latter have functional eyes to use in detecting their prey

Entrance to Smallin's Cave. On leaving the outer world one experiences a drop of temperature of from 20° to 40° F.

Netting blind crayfish. In Smallin's Cave more blind crayfish were found than in any other locality

"THE GULF OF DOOM"

Underground passageways sometimes lead to the brink of stupendous chasms. The exploration of these great black spaces is attended only with extreme difficulty because of the crumbling character of the rocks. One of the passageways in Marvel Cave follows the edge of the "Gulf of Doom"

attended only with extreme difficulty because of the crumbling character of the rocks. One of the passageways in Marvel Cave follows the edge of the "Gulf of Doom"

LOST RIVER

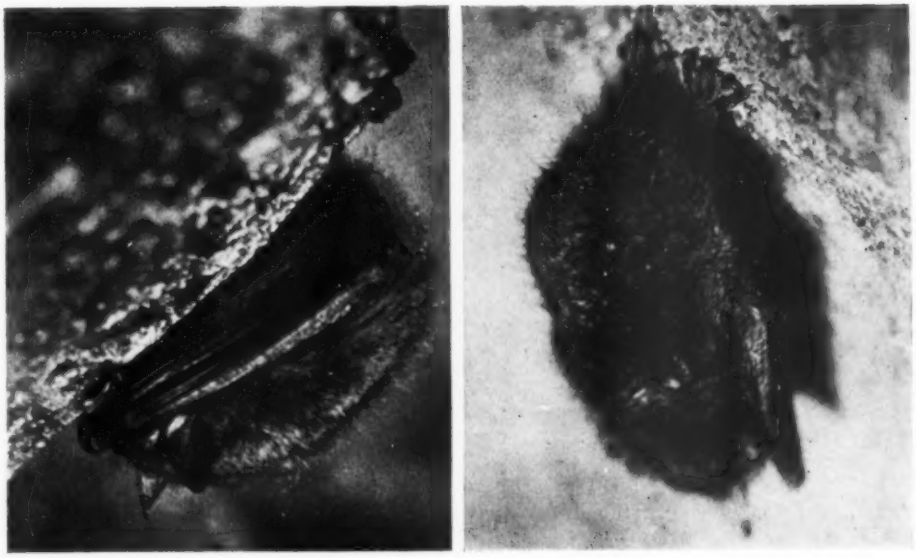
Lost River in Marvel Cave flows from under a ledge of rock, fills a hundred stony basins with icy water, and then leaps into the obscurity of the "waterfall room" below. It is said that its water feeds some springs several miles from the cave

magnitude of the throne room with its walls ornamented with dripstone held us spellbound. It was half an hour before we began our perilous descent to the stream bed.

Beyond Blondie's Throne the passageway grows even more difficult as the pools become more frequent and deeper. But here collecting began in earnest. We soon caught one blind salamander under a stone in the water, two together under a stone beside a pool, and another that tried to slide past us in the narrow passage. But most surprising was still another which, when we disturbed it at the edge of a pool, made straight up a sloping bank toward a hole under the roof of the passage. Thus, these creatures with their sightless eyes must have well defined routes of travel and escape. By frequently touching their snouts to the ground they are able to make considerable speed between the loose pieces of lime and dripstone which floor their passageways.

Later we made other trips to Blondie's and to near-by caves, which presented equally difficult crawls. None of these was as successful as our first. The crawl farther up Mystic River almost ended in disaster. Just as our party were attempting one of the worst squeezes, a swarm of several thousand bats started through the same opening. The squeaking, fluttering hords almost stifled John, our guide, who was in the lead. They crawled up his trouser legs, down the open neck of his shirt. When they began to pile up as a solid, squirming wall directly across the crevice, the thought of whether there was enough oxygen for all struck the members of the party at the same time, and without

Thousands of bats spend the winter in the passageways of Marvel Cave and the murmuring sound of many wings always follows the explorer



The Georgian bat, *Pipistrellus subflavus*, is the smallest in the United States, but the squeaking of the hordes when roused from hibernation is deafening

waiting for further demonstration, a retreat was at once begun.

After a day below ground struggling in the mud and drip of the passageways we were always glad to spend the following day in pursuing some task which would keep us in the sunshine. Our attention turned first to the amphibian faunas that lived on the surface of the ground. These we found were very accessible because they were concentrated in the only places where any surface waters occurred.

There was a spotted frog very similar to our eastern leopard frog, but with a white mark in the middle of the tympanum. In this and certain other characters it seemed to grade into the southern *R. sphenocephala*. The leopard frog is one of the earliest frogs to breed in the spring, and it was a great surprise to find in middle September a mass of eggs that this frog had laid in one of the warm pools. By far the most abundant amphibian along these wet seeps was the cricket frog, a diminutive tree frog which has given up life in the trees to frequent the edges of stony pools. Nevertheless, it has retained the structural characters of a tree frog including the adhesive disks on the ends of the digits.

That part of the amphibian fauna which especially claimed our attention was the salamanders. The question which we had always before us was, how did the blind and colorless cave salamander, *Typhlotriton*, come into existence? Many salamanders enter caves of their own volition seeking the coolness and moisture they require. The large reddish species *Eurycea lucifuga* is so frequently found in caves that it is sometimes said to be adapting itself to cave life, although it shows no adaptive change either in eyes or coloration. Under the wet rocks of the trickles, sometimes at a great distance from any cave, we found *E. lucifuga*, although not as frequently as the more abundant species, *Plethodon glutinosus* and *Eurycea melanopleura*. In the

Our wet clothes thrown off upon our emergence from the cave were quickly covered with butterflies seeking moisture in the dry outer world

East the first of these two species is abundant, but never found in stream beds and rarely in caves, for the woods are sufficiently damp to supply all the moisture requirements of the species. But in the Ozarks nature is severe and all moist-skinned salamanders, in order to survive, crowd together about these seeps, or springs. After a hot climb over the barren hills, we could well understand why all of these species were found in such limited regions. The same creatures were later found abundantly in caves, sometimes far from the entrance in regions of perpetual blackness. They were not in the act of adapting themselves to cave life; they were merely existing in one of the few places that moist skins could survive.

A cave salamander that has lost neither eyes nor pigmentation, *Eurycea lucifuga*, startled by the intruders

Among the fishes, detailed field studies of Eigenmann, Hubbs, and others have shown that the caves have not been peopled by the accidental entrance of epigean species. The first step in the origin of blind fish has been the acquisition of light-avoiding and cranny-seeking habits together with an increase in the importance of tactile and olfactory organs in the securing of food. In other words, fishes sought the caves through choice after they had

developed habits which necessitated their entering cave or semi-cave conditions. Further, fishes in the process of becoming blind cave species, have been described in several families, showing beyond any doubt that this has been the *course* of evolution in this group. Such an explanation reveals nothing about the *causes* of cave fish evolution; it merely opens another approach to the problem. Change of instinctive habits seems, from the work of Coghill on amphibian larvæ, to be a phenomenon of growth. Neurones grow and extend their processes until they make connections with new nerve-muscle segments. The cave-seeking habits of the fish are forced upon them by growth or by physiological changes in their nervous mechanisms, and the failure of the eyes to develop has followed as a secondary phenomenon.

Returning to the salamanders, for blind fish do not occur in the hilly parts of Stone County, conditions are found to be different from those usually described by evolutionists. All plethodontid salamanders having an inherited abhorrence for light, or to express it more exactly, being negatively heliotropic, would normally enter caves. Further, in the arid Ozarks all species retreat to caves and some may penetrate deep into the ground. Why, then, has only one species become blind when experiment has shown that blinded salamanders can feed successfully? Our attack on this problem began as soon as we reached the springs, for here we discovered to our surprise that the larvæ of *Typhlotriton* were abundant. Unlike their parents they were densely pigmented and had well developed eyes. Those we captured with our wire scoops exhibited such a range of size that it was apparent that the older ones had passed several years as spring-living creatures.

In the outer world the amphibian fauna was congregated about the spring "seeps." The leopard frog and cricket frog (right) were the most abundant species

A study of a great many springs in Stone and adjacent counties revealed that the larvæ were far more abundant in springs outside of caves than within the region of darkness. This is true even though the larvæ are negatively heliotropic—individuals kept in a tank retreating under the débris during the day and appearing again during the night. In the springs with *Typhlotriton* we found the larvæ of the rare *Eurycea multiplicata*. These also varied

In Wood's Spring (left) hundreds of young blind salamanders were found. The spring water which trickles from beneath the hills soon sinks into the ground to rejoin the underground streams

greatly in size and must have a prolonged larval life. A few metamorphosing *E. melanopleura* were found in some springs, but as these were of small size, it was clear that they, as do all plethodontids of the Ozarks, save *Typhlotriton* and *E. multiplicata*, metamorphose the first year.

A detailed examination of the springs and caves revealed that the adult *multiplicata* was thoroughly aquatic, reminding one greatly of the eastern *Leurognathus marmorata*. On two occasions the adults were found half a mile in from the entrance of a narrow, winding cave. Such regions are, of course, perpetually dark, but the *multiplicata* had well developed eyes and pigmentation. The larvæ, on the other hand, showed a distinct preference for warmer spring waters. In springs where the temperature ranged below 65° F. *Typhlotriton* was the dominant larva. Where it rose above this level *multiplicata* became much more abundant. Springs flowing for a distance under the surface rock and warmed to 70° usually contained only *multiplicata* larvæ, although among the great number of records obtained exceptions have been found. In brief, of all the Ozark salamanders obtained, only two have an extended larval life in the water, and these two species usually avoid competition by selecting waters of different temperatures. The species which frequents warm water metamorphoses without losing either its eyesight or pigmentation, but the one that lives in cold waters undergoes a remarkable change at metamorphosis, its pigmentation is reduced, and the eyelids which form never open more than a small slit. The retina behind the partly closed lids undergoes certain degenerate changes.

Both species during their larval life are highly thigmotactic, that is, are more comfortable when in contact with several surfaces, and spend much of the day between rocks among which water flows rapidly. In the pile of loose stones at the mouth of Wood's Cave, an area only 22 ft. 6 in. by 5 ft. 10 in.

in extent, more than three hundred larvæ were captured. We found one adult but no larvæ, in the many yards of pool gravel within the cave. If metamorphosis brought with it an urge to climb away from the rushing spring water to the quiet cave pools beyond, these larvæ, which even before metamorphosis readily climbed out of my milk cans and other containers, would most surely make their way into the caves, for the only other direction not flanked by scorching blocks of limestone led to the warmer pools which we knew by both observation and experiment were not favorable to the species.

The problem of blindness and depigmentation in these salamanders appeared as a problem of metamorphosis and not one of progressive adaptation. Laboratory experiments of recent years have thrown much light on the nature and mechanism of metamorphosis. The rôle of the thyroid hormone in producing metamorphic changes is well known, but the importance of external factors in altering the end result is not so clear. Thus, it is possible that *Typhlotriton* raised in waters of different constitution or temperature might show a greater or less degree of these metamorphic changes. The immediate problem of the importance of external vs. internal factors in producing the ghostly creature found in the caves is removed from the domain of field observation to that of laboratory work. The adult *Typhlotriton* have never been found outside of the caves, and yet each generation of larvæ spends two or more years outside of the caves as well formed and pigmented salamanders. The destructive changes of metamorphosis necessitate a retreat to adjacent caves, where a combination of external and internal factors results in the animal adapted to cave life. Generations of cave life have not affected the form of the larva and, without laboratory analysis, who can say that it has permanently affected any feature of the animal's heredity, even its metamorphosis?

In transporting and handling our salamanders many problems presented themselves. In order to bring larvæ from the surrounding springs to our base camp at Marvel Cave we found it necessary to carry the containers on ice. Further, the larvæ shipped better in wet leaves than in water. All these facts were learned only with the sacrifice of life. By constant vigilance and care we have managed to bring several hundred larvæ alive back to New York, where they are now available for laboratory studies which we believe will throw further light on the importance of environmental vs. hereditary factors in the origin of blindness and depigmentation in the cave salamander, *Typhlotriton*.

Returning to camp with a load of living blind salamanders safely packed on ice

The Coral Seas of Michigan

By E. C. CASE
Director, Geological Museum, University of Michigan

THERE is on my desk a small piece of limestone, weighing perhaps a couple of pounds—just a small fragment of the enormous mass of very pure limestone that daily is being torn from the ground in northern Michigan by hundreds of tons and is being shipped to the iron smelters, the cement mills, and the manufactories of chemicals. This small bit of limestone is in a way a key to the origin of one of the greatest resources of the state, for it is a fragment of one of the innumerable coral reefs which form so large a part of the rock foundation of Michigan.

Last summer I was one of a party engaged in making a survey of the northern part of the southern peninsula of Michigan to determine the position and thickness of the limestone beds, in order that the quarryman might more surely locate the pure stone and more profitably exploit it. Armed with hammer and compass and notebook we invaded many a quarry that was being worked and many that had been abandoned. We tested the rock and robbed the different layers of fossils which would tell the age of the beds and, by comparison with fossils from other beds, the extent of the deposits. Very soon we began to realize that in a great arc reaching from one side of the state to the other, from Charlevoix to Alpena, we were dealing with the deposits of an ocean where reef after reef had grown to the surface and felt the force of battering waves now stilled for millions of years.

The more evenly bedded layers of limestone and shale formed from the mud of the ocean bottom are interrupted again and again by irregular masses of rock composed almost entirely of the calcareous skeletons of corals, bryozoans, and the innumerable forms of life which frequent coral reefs. Among the fossil corals lay the shells of the cephalopods—the shelled ancestors of the modern squid and cuttle-fish, of brachiopods—the "lamp shells" and "butterfly stones" of the quarryman, of crinoids—the "stone lilies," and of trilobites whose kind disappeared from the earth when the development of life was little more than half accomplished. All these lay as they had lived in the holes between the corals, or where they had been cast by the surge and reflux of the waves.

We came to know these reefs most intimately for they were the subject of our daily study for several weeks, but I wondered what the hard-headed business men who had sent us upon the survey and who were dependent upon the results of our work for their profit would have thought if they had known what I was really doing much of the time. Clad in khaki and stout boots, armed with hammer and rule and chisel, I was apparently clambering about steep quarry faces, measuring the thickness of the layers, testing the quality of the stone, knocking off samples for analysis or chipping out fossils for comparison, so that I might make a report in so many tons of limestone to feed so many blast furnaces, or mills, or factories. In reality I was often a diver sinking slowly beneath the waters of an ocean so old that the stars of the constellations were in other combinations, and would shift and regroup themselves many times before they came to stand as we see them now.

Slipping down the quarry face between the steam shovel and the drilling rig—really holding my breath as the green water closed over me, pausing at a layer crowded with fossils—really feeling the soft mud of the ocean floor rise about my feet as I bent to peer between the waving, interlacing branches of living colonies of animals, stopping to crack out a brachiopod—or the test of a trilobite—really stooping to gather an iridescent shell or snatch at a living trilobite as it scuttled to safety beneath a bushy coral, or breaking the stem of a fragile "stone lily," I was an explorer in regions where man's foot had never trod, a hunter of animals whose kind had passed from the world more than sixty milleniums ago.

In such a mood, I dropped over the edge of the great quarry at Alpena, sinking down, down, down, through 125 feet of imagined water until I came to rest on the ocean floor at the bottom of the pit where I found my little piece of limestone. The floor of the quarry was a grayish, shaly limestone, the hardened mud of the quiet ocean bottom filled with the débris of corals and shells all broken and powdered by the constant movement of the waves. Before me was the reef on which the waves had broken. The face of the stone, shattered by the rending dynamite of the quarryman, was a section of the reef a hundred feet long by twenty feet thick, with how much more hidden under the stone no man can know. The corals lay there as they had lived, and built up the reef. Colony after colony of the kind called *Acervularia*[1] had started, each from a minute bud, and had grown by the addition of individual after individual to the central mass. The colonies, or "heads," were packed and crowded, piled one upon the other just as they

Specimen of a cup coral standing upright as it grew upon a head of *Acervularia* more than sixty million years ago. From the quarry of the Michigan Alkali Works at Alpena, Michigan. Note the mat of bryozoans or moss-animals at the foot of the cup and near the top

[1]Except for the upright cup coral the pictures are taken from Rominger's Fossil Corals of Michigan, Volume III of the Report of the State Geologist of Michigan, 1873–1876.

had lain in the time of their lusty lives until some change in the temperature or the salinity of the water, or some lack of food supply killed them all, and the reef passed into the initial stages of ruin.

Such a reef contains many kinds of corals. In some the individuals crowd close together, each adding its portion to the common mass, similar species always forming similar patterns, but there is seemingly an endless variety of patterns for the different species. Other corals are solitary in their growth, each individual building unto itself the hard calcareous skeleton which takes the form of a cup or cornucopia. During life these fragile cups stood upright upon the smaller end, but after death they were almost invariably broken from their slight support by the moving water and left lying upon their sides, or broken into fragments.

The cup coral (*Heliophyllum*). Note the radiate appearance of the septa in the cup, suggesting the name

In the reef I was looking at there was a single cup coral which had taken its start upon one of the heads of *Acervularia* and had grown as fragile and upright as a Venetian wine glass. In life the cup was filled by the body of the living animal, perhaps as vivid in color as ruddy wine, its cluster of tentacles waving in the water to catch its food or shrinking from the touch of a passing fish. By some happy chance several heads of *Acervularia* had grown around this single cup coral, of all the thousands of its kind, and warded off the common fate. So I came upon it—after it had lived and died, after the beauty of its flesh had melted from the skeleton, after the skeleton had been transformed into stone, after more than sixty million years of burial. The chalice stood even as it had stood when brimming with life, unharmed, almost unchanged.

Most carefully I cleaned away the surrounding rock, most carefully I loosened the fragile thing that had escaped the possible accidents of æons of time and the final shattering blast that had resurrected it, most carefully I wrapped it in fold on fold of the softest tissue. Now up, up, through the waters of the old Devonian ocean, up through age on age of geological time until I emerged at the surface into the bustle and roar of the rock crusher that was devouring the world I had left.

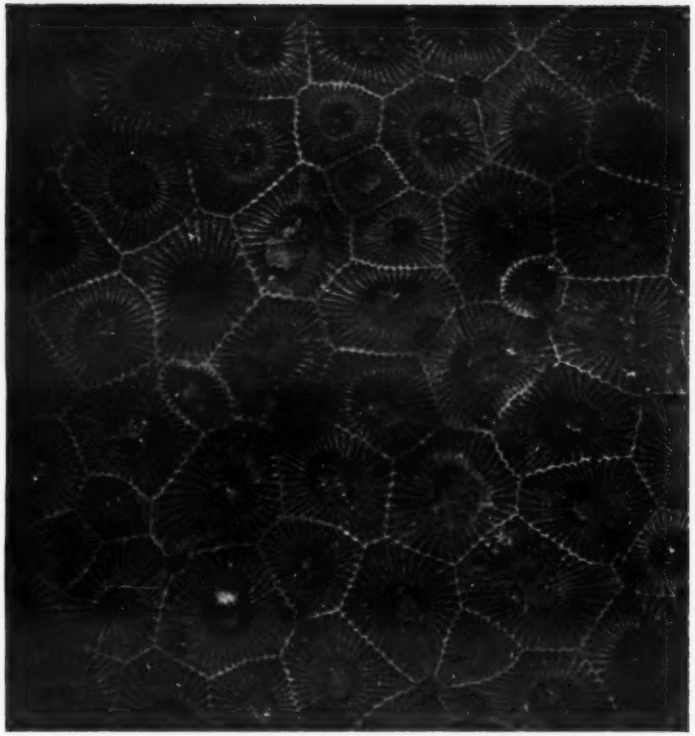
In the laboratory my little fragment of limestone had still more of its history to reveal. The waves had ground to blue mud the skeletons of thousands of less fortunately placed

corals and the mud had settled down into every crack and crevice of the reef, finally hardening into the limestone which masked even as it protected the specimen I had recovered. Patiently and by slow degrees, the limestone was cleared away until I could see the whole, and then it was revealed how crowded and strenuous had been the life upon the reef. As soon as the polyps which built up the head of *Acervularia* had died and the decay of its soft parts had laid bare the skeleton, the hard surface was seized upon by other forms of life as a support. Soft, living mats formed by colonies of bryozoans crept over the surface, each minute individual adding its tiny part to the intricate, lacelike skeleton of the colony. Not one, but several such mats are present on the specimen, covering parts of the large head of *Acervularia*, covering each other and creeping up on the sides of the cup coral. The skeletons of the colonies of bryozoans are so small in structure that they must be examined under a magnifying glass, so accurate in the placing of each part that the same species may be recognized among a thousand specimens, so beautiful in their tracery that even the curiosity of the scientist prying into the ultimate secrets of form and relationship is diverted into wonder and admiration. It is a far cry from the collection of ancient Belgian lace in the museum at Bruges to the bottom of a limestone quarry in the New World, but, in the bottom of a muddy pit, I have bent over a fragment of shale or limestone carrying a bit of the skeleton of a bryozoan, with much the same feelings as when I pored over the cases of priceless lace in that historic building.

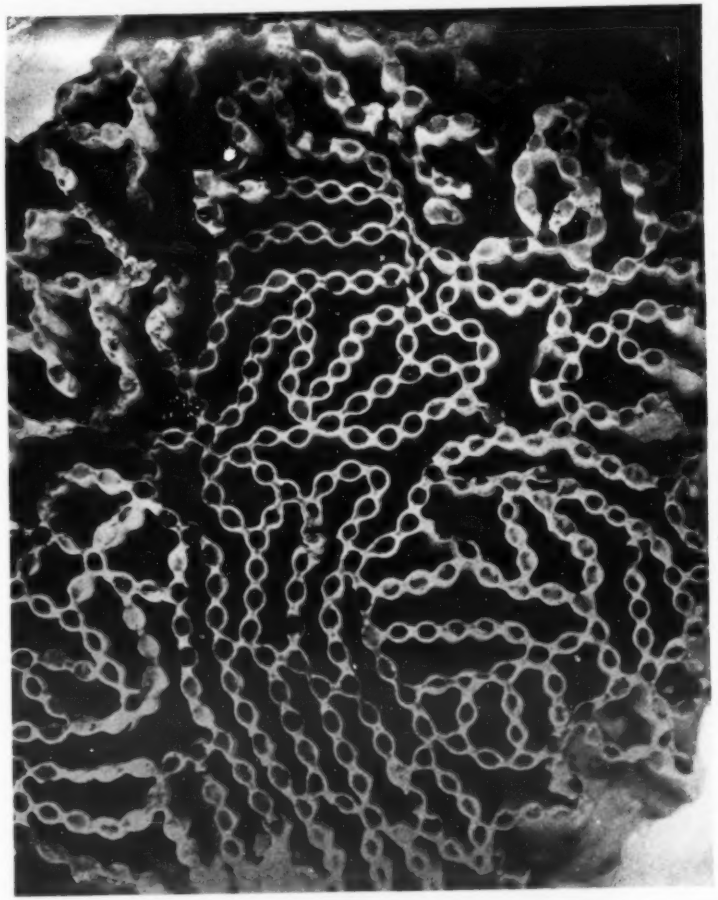
The bryozoans were not the only forms that seized upon the support afforded by the dead coral. Wormlike "serpulids" fastened themselves there and left their tiny coiled shells scarce two pin-heads in size; certain of the brachiopods abandoned their free life and fastened themselves to the same support, self condemned to cease from their active endeavor and henceforth take what might come. Their shells still cling to the support, mute witnesses of their surrender. So one diving trip ended in the recovery of my little piece of limestone with its history.

Beebe has told us how from his diving helmet his vision can penetrate but a short distance through the clear water and how he was tantalized by dim visions of shapes wavering in the obscuring haze. In the same way the dreaming geologist is tantalized by dim visions of weird forms of life only half revealed, but to him the obscuring haze is one of time and of only partial preservation of the remains. A scale, a tooth, a fragment of a plate gives but a half revealing glimpse of some fish that once haunted the reef. In those early days it was the fashion to wear the skeleton on the outside of the body,—scale armor and plate armor are infinitely older than the mediæval knight who consciously or unconsciously copied the fashions of his remote predecessors. When these oldest of the armor bearers died, their bony plates, scales, and loosely fastened teeth soon fell apart and were dispersed on the reef or the ocean bottom. The palæontologist finds a tooth, sharp as a lance head, and knows that where he stands there once drifted the body of a sharklike creature whose approach was the terror of all the smaller forms. Smaller

Head of a honeycomb coral (*Favosites alpenensis*) which grows in long heads and stalks



Polished surface of a head of fossil coral (*Acervularia*) showing the structure of the separate corallites



Halysites, the chain coral, showing the chainlike appearance of the joined openings of the individual corallites

A bit of a head of fossil coral, *Diphyphyllum*, similar in appearance to *Syringopora*, except that the individual corallites are larger in diameter

teeth with sharp chisel edges and a grinding surface are all that is left of fish which browsed among the corals, nipping off the buds of the living polyps and grinding the fragments to powder, or wrenching from the holes and crannies of the reef such forms as had sought protection by hiding there. Occasionally the palæontologist finds fragments of great plates, or by good luck whole plates, of the giant *Dinichthys*, a rapacious form from 20 to 30 feet long, with great shearing jaws that were longer than the span of a man's arms. I have found such plates, and in my explorer's mood may well be forgiven the shudder of apprehension that comes to the diver as he sees the dim outline of a great shark bulk waveringly through the haze of the waters above him.

Perhaps I have led the reader into a strange, and for the most part unknown world, but if he will have the patience to bear with a few details, the way of the palæontologist will no longer seem that of a mere "thanatologist," a dealer with the dead and relics of the dead, but rather a "palæobiologist," a student of the life that is past, the life that struggled forward to the things that we see about us now.

The term "coral reef" may be taken in a somewhat general sense to include the great assemblages of life which build up the barrier and fringing reefs of the islands and continents of the tropical seas. Such reefs are formed in large part by colonies of corals, bryozoans, hydrocorallines and similar forms which secrete calcareous matter from the sea water and build it into the hard parts of their bodies. When the animals die, the indestructible calcareous skeletons build the stony mass of the reef. Associated with the colonies of animals are many forms of plant life, "sea weeds," which contribute as much or more of the calcareous hard material as do the animals. The reefs grow to the surface of the water where the force of the waves breaks off bits of the stony matter and grinds them into fine mud which is distributed in even layers on the near-by portions of the ocean floor. These form the layers of shales and limestones, but through the even layers project the irregular masses of the reef which was the source of all the material around them.

The majority of living corals can not endure a temperature below 69° Farenheit, nor a depth much greater than one hundred fathoms; they are all marine in habit and as they live with their mouths generally upward and open to all that comes, they may not survive in muddy water where the sinking sediment would choke out their lives. So far as we may determine, the habit of the ancient corals was not greatly different from that of the living forms, and so, when we find a bit of coral in the limestone or shale, we may be certain that at some time in the past the place where we now stand was covered by a warm, shallow sea.

The estimates of the extent of geological time are so various and so discordant that it is impossible to decide between the many hundreds of millions of years demanded by the students of radium and the few hundreds of millions of years which are sufficient for the students in other branches of science. Figures so vast mean but little for they are all beyond the grasp of the human brain. Professor Schuchert of Yale University has suggested that the extent of time since life appeared on the earth is,

perhaps, in the neighborhood of 300,000,000 years, and that the time since the rocks first received remains of life that could be preserved as fossils is something like 250,000,000 years. These figures will at least serve to give some idea of the order of the numbers with which we must deal.

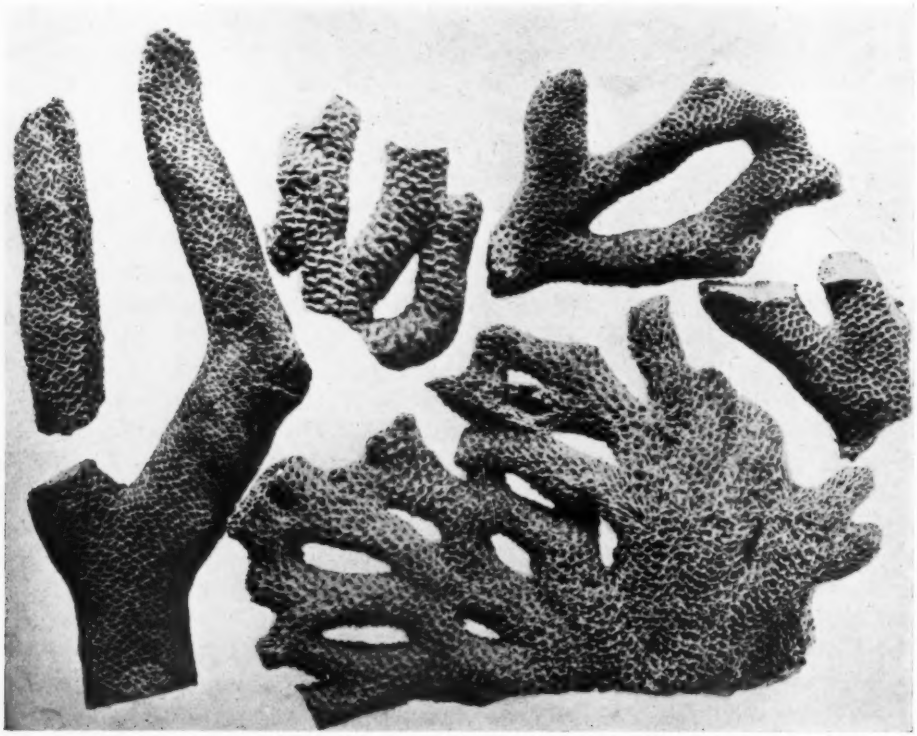
The 250,000,000 years is divided by geologists into three great eras, the Paleozoic, the Mesozoic and the Cenozoic. The first of these is divided into several epochs, the Cambrian (the oldest), Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and Permian. It is altogether probable that with the increase of knowledge the number of these divisions will be increased.

In a broad way, the state of Michigan can be thought of as a pile of saucers, each geological formation a single saucer resting upon the one beneath and the rims of the various saucers appearing on the edge of the pile. The youngest of the formations is the Pennsylvanian appearing in the center of the State. The successively older formations appear as the concentric rims around the center. Toward the north, the oldest of the formations, the Cambrian, forms the southern shore of Lake Superior. South of this, the next younger rocks, the Ordovician, extend from Bay de Noc on the west through the center of the northern peninsula and are continued on the northern shore of Drummond's Island. South of this, the next younger, the Silurian, forms and parallels the southern shore of the northern peninsula and forms the southern side of Drummond's Island. Next come the rocks of the Devonian which sweep in a great arc, first northeast from Charlevoix and Petoskey, on the west, and then southeast to Alpena, on the east.

Along each of these arcs the harder limestone of the coral reefs thrusts itself through the soil which covers the areas where the softer rock has been removed by erosion. Most of the rocks of the Ordovician arc are hidden by swamp and forest, but on the northern side of Drummond's Island the waves have swept the rock clean. Here I have stood upon the shore and looked down through three feet of the clear waters of Lake Huron upon the surface of a coral reef as beautiful in form as any reef of the southern seas. Perfect heads of the compound coral *Columnaria*, so called because of the rigidly straight skeletons of the individual corallites, lie crowded together with every detail of the structure etched into perfect relief by the solvent action of the water. Between and on the heads lie the cornucopia-like skeletons of the solitary corals and in every depression lie the shells of brachiopods, trilobites, cephalopods, and crinoids. In every detail it resembles a living reef except that all has been stilled into imperishable stone. The waving sea weed, the scuttling crab, the frondescent colonies of bryozoans are quiet, but how easy in imagination to make the whole quicken into action and to see the gorgeous colors creep over the gray stone, tinting them as the coming of morning tints the gray eastern sky.

A short distance north of this reef, on the shores of little Sulphur Island there is a bit of ancient history clearly graven in the stone. In the most remote days of the earth's history, long before living things had learned to build the hard parts that might remain as fossils, a mass of sand was gathered together by wind, or wave,

or river. Later this was cemented together into a hard sandstone and then the whole was buried beneath the accumulations of later time. How deeply it was buried and for how long a time we may not know, for that part of the record has disappeared forever. In some disturbance of the earth's crust the sandstone was heated and squeezed until it became a very hard, compact quartzite and then was raised again to the surface. Just when it was raised and when it became again a part of the ocean shore we do not know, but certainly it was facing the waves of the ocean in Ordovician time. We do know that the sea of Ordovician time beat against the quartzite, carving it into cliffs and tearing down masses that were ground to bowlders on the beach, for after this had gone on for some time the shore began to sink again and the waters crept over the rocks, depositing the gray mud of the ocean floor upon and between the bowlders and finally covering and burying the whole cliff. In the mud and on its surface lived thousands of the animals of Ordovician time and their fossil remains now lie encased in the limestone between the bowlders, and in the cracks of the rock of the cliff. The whole region was buried for an unknown length of time and then raised again to feel anew the beat of storm waves. Today the waves of Lake Huron are tearing away the Ordovician mud and beating upon exactly the same surface, exactly the same grains of the quartzite



Cladopora, a form of branching coral very common in Michigan. It is easily distinguished by the oblique position of the openings

that were beaten by the waves of the old Paleozoic sea, at least eighty millions of years ago.

On the south shore of Drummond's Island, at the little village of Raber near Detour, and at Engadine and Gould City along the line of the Minneapolis and Sault Ste. Marie Railroad, the reefs of the Silurian seas are especially prominent. Here the searcher must watch the stone fences and the piles of rock culled from the ploughed fields, or crash his way through the thick second-growth timber and brush to some burned off spot where the soil has been washed away and the rock revealed. I once started with a friend across a ploughed field near Gould City. In five minutes our arms were filled with fossil corals so beautiful that they simply could not be left behind, but fossils are heavy and soon our burden was deposited in a fence corner. The walk was resumed, but only to repeat the process again and again. The next day we chartered a wagon to bring our treasure trove to the railway station. On one small piece, not more than one foot by two feet, which I pulled from a farmer's fence, I identified thirteen different varieties of corals and bryozoans.

In these reefs are found the heads of *Favosites*, the "wasp nest" or "honey comb" coral, occuring in a dozen different habits of growth, from masses several feet across to colonies no larger than a golf ball, in broad, wavy sheets, in irregular cylinders, in branching and digitating masses. Here is found *Halysites*, the "chain coral," with long, slender corallites attached edge to edge in thin walls that cross and intersect; the mouths of the corallites appear as a succession of small, oval openings like the links of a chain. Here is the *Syringopora*, the "organ-pipe coral," a series of semi-detached tubes which the author of the genus likened to the pipes of a syrinx. Here, too, an amazing number of the cup corals lie scattered along the reef, large and small, slender and stout, some flat as a button, some like small horns of plenty.

By a happy chance, the substance of the corals found in this region has been changed into silica, which is much more resistant to the action of all the weathering agents than the limestone in which they were enclosed. I have frequently stumbled upon a piece of white silica sticking out of the black soil and with a little care, have recovered a perfect skeleton of one of the corals.

South of the Silurian reefs lies the land of the Devonian, described above in the account of the little piece of limestone. To most people who go to northern Michigan it is a land of lakes and summer resorts. Beyond the hotel and the lake there is only glacial soil and much unproductive sand. To them it is a land of swamps and thick brush where the pine and the other forest trees have been cut away, where unsightly skeletons and blackened stumps tell where the fire has swept again and again through the forest. If the visitor will don something of the outfit of the geologist, his hob-nailed boots and khaki, arm himself with a hammer and chisel, and then let himself sink beneath the waters that have built up the substance of some of the great quarries, he will find Michigan is a land where the waves once broke on the coral sands, a region of romance where beauty can still be rescued from the jaws of the dragon steam shovel, a land—

> Where the sea-egg flames on the coral,
> And the long-backed breakers croon
> Their endless ocean legends
> To the lazy, locked lagoon.

TIDE HOUSE AT TAHITI

The Truant Tides of Tahiti

By H. A. MARMER

Of the U. S. Coast and Geodetic Survey

A THOUSAND miles below the equator and very nearly midway between South America and Australia, the island of Tahiti rises from the depths of the South Pacific Ocean. Only a few miles from its palm-fringed beaches, the ocean is more than ten thousand feet deep, while a few miles inland the crest of Orohena towers more than seven thousand feet above the surf.

It was in a generous mood that nature fashioned Tahiti. Bestowing on it the gift of perpetual summer coupled with a pleasant, healthful climate, a fertile soil, riotous vegetation and waters matching the productiveness of the land with a wealth of fish of all kinds, it added the further gift of varied and enchanting scenery: within the compass of a few miles, coral strand and mountain peak; waterfalls leaping hundreds of feet down precipitous cliffs; streams of entrancing beauty, their courses bowered with tropic verdure; lovely river-threaded valleys abounding in fruit and flowers.

For the past hundred and fifty years, since it first became known to the civilized world, the charms of Tahiti have been sung by all who touched its shores. The spell of its indulgent climate, its people of splendid physique, and more especially the charm and grace of its friendly feminine population, have combined to make of Tahiti a name that conjures up pictures of romance and adventure, a place that invites to truancy from labor and from the compulsions of civilization.

Not only have visitor and native alike responded to the spell of Tahiti, but the sea itself appears to have succumbed to the spirit of truancy. Over the vast expanse of the seven seas it is the moon that is mistress of the tide, compelling its rise and fall to keep step with her own movements; but at Tahiti, while the tide acknowledges the sovereignty of the moon, it also plays truant and pays very nearly as great homage to the sun, so that here sun and moon play approximately equal tidal rôles.

SUN, MOON, AND TIDE

To understand the full significance of the strange behavior of the tides at Tahiti, it will be of advantage to consider for a moment the normal relations of sun, moon, and tide. That the moon and the rhythmic rise and fall of the sea, which we call the tide, were in some way intimately connected, must have been discovered early in the life of mankind; for, not only does the tide vary in the amount of its rise and fall with the moon's changing phases, but like the moon it also comes later every day by about fifty minutes. That the sun, too, is concerned in the rise and fall of the tide is evident from the fact that at times of full and new moon, when sun, moon, and earth are in line with one another, the tides have their greatest rise and fall; while when the moon is in her first and third quarters, that is, when sun, moon, and earth are at the vertices of a triangle, the rise and fall of the tide is at a minimum.

Before the beginning of the Christian era, the Greeks and the Romans had recognized the fact that the tide was brought about by sun and moon, and they recognized, too, that the moon played the leading rôle. But the agency by means of which sun and moon produced the tide remained a mystery for many centuries. Indeed, it was not until the genius of Newton in the latter decades of the seventeenth century discovered and formulated the law of gravitation that the connection between moon and tide received a rational explanation.

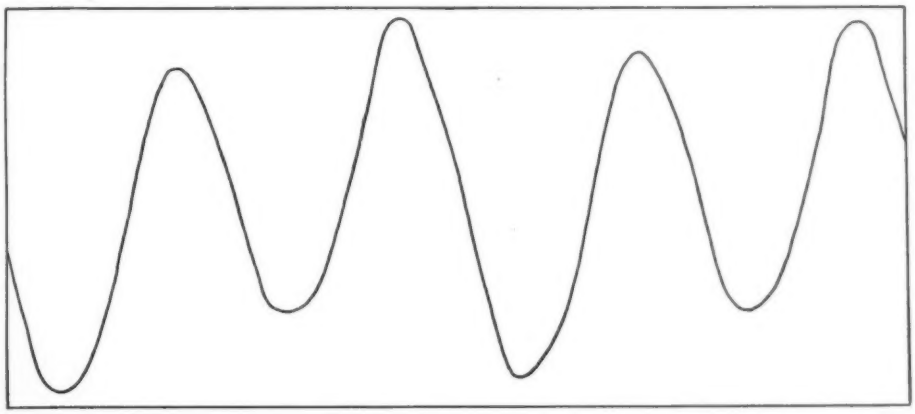
At first thought it is something of a paradox that in controlling the tidal movement of the sea the sun must yield supremacy to the moon, for the sun is the source of energy and master of life on land and sea. It holds both earth and moon in subjection, compelling them to attend as satellites. In size, too, the moon compared to the sun is altogether insignificant; the sun can furnish material to make twenty-six million moons and still have enough left for something like ten thousand planets the size of our earth. Why is it then that the moon plays the leading rôle in the production of the tides, making the length of the tidal day the same as the lunar day and compelling the tide to keep step with her own movement? What explains this seeming paradox?

The explanation is found in the laws of celestial mechanics. When, on the basis of universal gravitation the mathematician works out the law that governs the tide-producing power of a heavenly body, he finds that there are two parts to it. First, the power of a heavenly body to produce tides varies exactly as the amount of matter in the body, the greater the body the greater the tidal force. Second, the further away the body, the less the tidal force, but in such manner that when the distance is doubled the tide-producing force is reduced eightfold; or as the mathematician expresses it, the tide-producing power of a heavenly body varies directly as its mass and inversely as the cube of its distance.

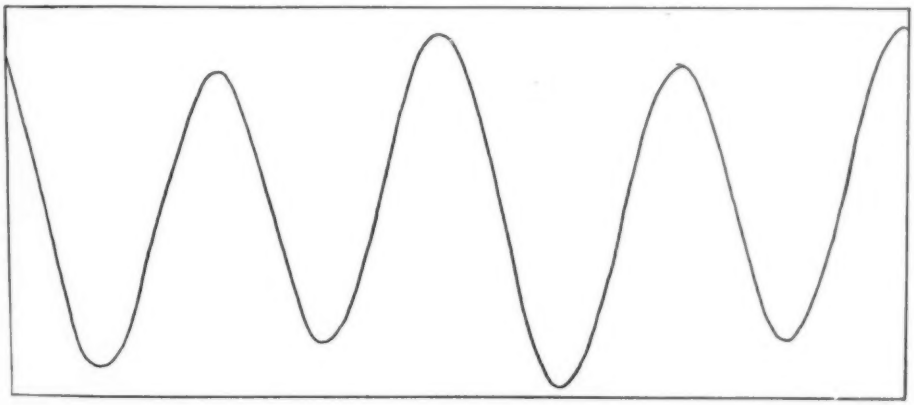
Applying these laws of the tides to the sun and moon, it would appear at first glance that because of its enormous mass, the sun's tide-producing power should be much greater than that of the moon. Indeed, if moon and sun were equally distant from the earth, the sun's tide-producing power would be 26,000,000 times that of the moon. But the moon is 389 times nearer than the sun. According to the second part of the law of tides, therefore, the moon's advantage over the sun because of its nearness is found by cubing 389 which gives, in round numbers, 59,000,000. The moon therefore because of its nearness overcomes the advantage of the sun's greater mass in the proportion of 59,000,000 to 26,000,000; that is, the moon's power to produce tides on the earth is something like 2¼ times as great as that of the sun, and hence the tides the world over, with scarcely an exception, follow the moon.

THE IMPRESS OF LOCALITY

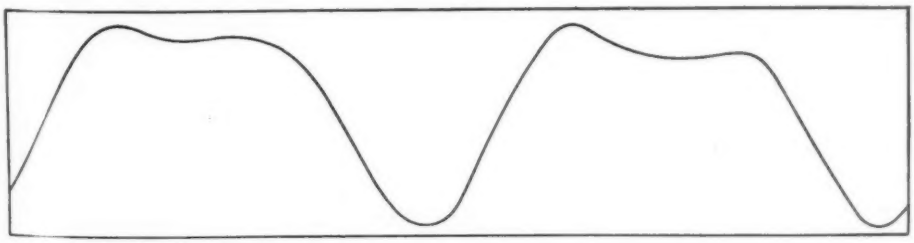
Since the tide-producing forces arise outside the earth in the sun and moon, it might be supposed that over the whole earth the tide would exhibit the same characteristics. And to the casual glance the tide appears to be cosmopolitan in character and to possess no local distinguishing traits to vary the monotony of its ceaseless rise and fall. On closer examination, however, this appearance of uniformity



Rise and fall of tide at foot of of the Statue of Liberty, New York Harbor. July 1–2, 1920. Height scale $\frac{1}{30}$ of nature



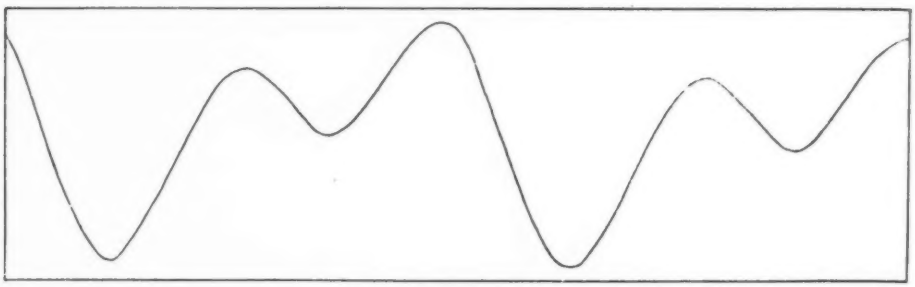
Rise and fall of tide, Portland Harbor, Maine. July 1–2, 1920. Height scale $\frac{1}{60}$ of nature



Rise and fall of tide, Galveston, Texas, July 1–2, 1920. Height scale $\frac{1}{15}$ of nature

is found to be deceptive. Not only do differences in the extent of rise and fall come to light—at some places it is less than a foot while at others it is more than forty feet—but each locality reveals distinctive features in the rising and falling of the tide that are typical for that locality.

By means of the self-registering or automatic tide gauge, the tide at any place can be made to write the story



Rise and fall of tide, Golden Gate, San Francisco Harbor. July 1–2, 1920. Height scale $\frac{1}{60}$ of nature

of its rise and fall graphically, furnishing a visualization of its history for as long a period as desired. Looking at such a tide curve representing the rise and fall of the tide in New York Harbor for the first two days in July, 1920, we see that despite its reputation for frivolity and the vagaries along its "gay white way" the tides that wash the shores of New York City are very regular in habits. High water and low water follow each other in a uniform manner at intervals of a little more than six hours, rising and falling approximately four and one-half feet. And regularly do these tides follow the moon, low water coming two hours after the moon has passed the meridian and high water eight hours after the meridian passage.

Now compare the tide curve at Portland, Maine, for the same days. Not one whit more correct is this New England tide in its behavior than the tide at New York. Here, too, the tide follows the moon regularly, and while both places exhibit the characteristic features of the Atlantic Coast tides, the impress of locality is seen in the differences in time and range of tide. At Portland the tide is about three and one-half hours later than at New York and the range is twice as great, being almost exactly nine feet.

Going farther away the differences in tidal characteristics become more striking. Glance at the tide curve representing the rise and fall of the tide at Galveston, Texas, for the same two days in July. Here the range of the tide averages but one foot, as compared with four and one-half at New York and nine at Portland. But what is even more striking is the character of the rise and fall. On the Atlantic coast the two high waters and also the two low waters of a day are approximately the same, the morning and afternoon tides resembling each other closely in all respects. In the Gulf of Mexico, however, the two high waters do not differ much but morning and afternoon low waters are so strikingly different that frequently the higher of the two low waters merges with one of the high waters and at such times there is but

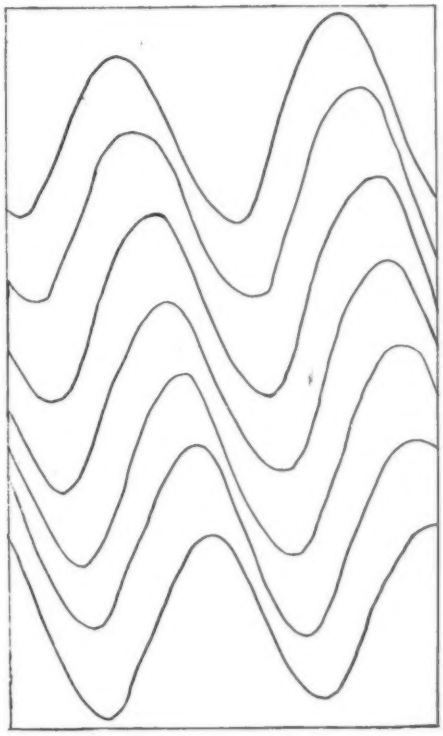
one high water and one low water each day.

On the Pacific coast the rise and fall of the tide is different from that on the Atlantic and Gulf coasts. The characteristic features of the tide that sweeps past the Golden Gate is exhibited by the tide curve for July 1–2, 1920. With an average rise and fall of four feet both the high and low waters of each day exhibit characteristic differences. And wherever tides have been observed, distinctive features in time, range, and characteristics of rise and fall are found that betoken the impress of locality.

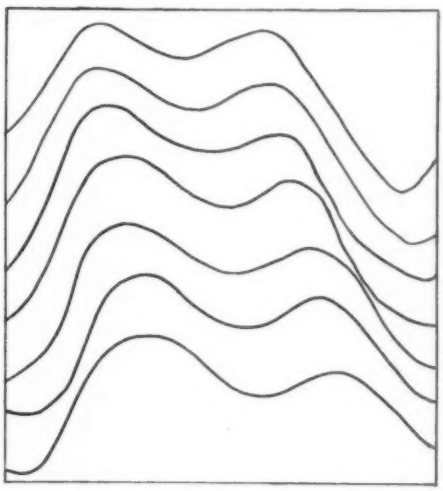
SOVEREIGNTY OF THE MOON

Notwithstanding the very decided differences shown by the tides in various regions, one feature they have in common almost without a single exception the world over, namely, acknowledgement of the sovereignty of the moon. Day after day the tide at any given place follows the moon's meridian passage by a very nearly constant interval. As the Venerable Bede expressed it twelve hundred years ago, "in every country the moon keeps ever the rule of alliance with the sea which it once for all has agreed upon."

Every day the moon crosses the meridian of any given place, on the average, fifty minutes later than the day before; and the tide at any point, with the striking exception of the region around Tahiti, follows the movement of the moon and likewise, on the average, comes later each day by fifty minutes. Heavy winds may disturb this regular succession somewhat, but only temporarily, the tides following the storm coming in their appointed time as if nothing had occurred to disturb the serenity of their way.



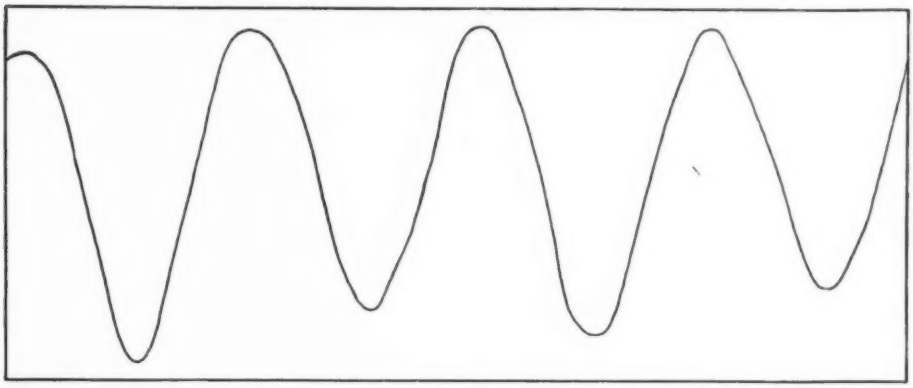
Tide curves, New York Harbor, June 4–10, 1921. Height scale $\frac{1}{65}$ of nature



Tide curves, Petropavlovsk, Siberia, June 11–17, 1828. Height scale of $\frac{1}{70}$ of nature

This retardation in the time of tide stands out clearly if we arrange the tide curves for any place, day by day,

in serried ranks like an army on the march. Whether in New York Harbor or on the coast of Siberia, in the polar regions or under the equator the retardation in time stands out in the curves as a shift to the right from top to bottom, which averages fifty minutes per day. This means in other words that in a week, each phase of the tide will have become later by almost exactly five hours.



Rise and fall of tide, Tahiti, September 1–2, 1924. Height scale $\frac{1}{9}$ of nature

BEHAVIOR OF TAHITI TIDES

At first glance the behavior of the tide at Tahiti seems to be altogether unexceptionable, the rise and fall appearing to exhibit no unusual features. Examining a typical tide curve for this island—exemplified by the tide curve for the first two days in September, 1924—we find it much like the tide curve at numerous other places. The range of the tide, to be sure, is small, being on the average less than a foot; but the general appearance of the curve is that of a regular tide curve.

If, however, we examine the succession in the time of tide at Tahiti from day to day, the fact will soon come to light that here the tide does not come later each day by the interval of fifty minutes which characterizes the tide at other places. Instead, there will be periods of a week or more when each phase of the tide comes about the same time on successive days. Here the tide curves for a week, arranged in serried ranks, do not show the distinct shift to the right found at other places; on the contrary, there is a pronounced tendency for the various phases of the tide, from day to day, to fall almost vertically under each other as exemplified by the tide curves for a week in September, 1924, as shown in the diagram on the following page.

Within the period of a week the tide at other places in the world would have kept time with the moon's motion so that at the end of the week each phase of the tide would be five hours later than at the beginning of the week. At Tahiti, however, as the week of tide curves shows, there is a barely perceptible shift to the right from top to bottom—instead of five hours it is somewhat less than two hours—and every day high water comes about twelve o'clock, morning and night, while low water comes about six o'clock in the morning and six in the evening.

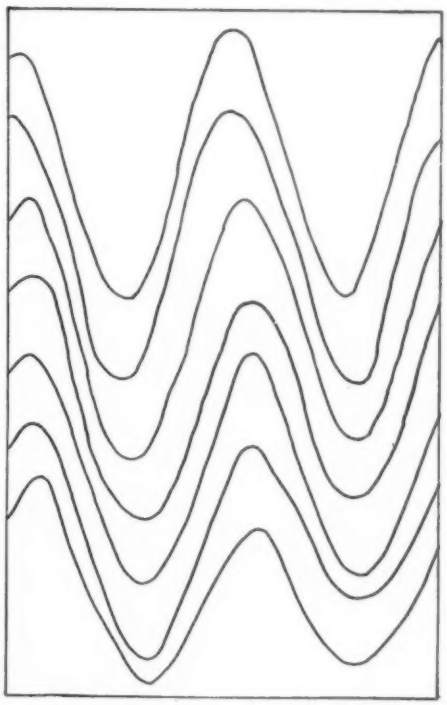
It is in this feature that the tide at Tahiti is exceptional. Instead of becoming later each day by very nearly an hour, the tide here tends to come about the same time every day. Indeed, as a general rule it is not incorrect to say that at Tahiti the tide is high about twelve o'clock morning and night, and low about six o'clock morning and evening. Colloquially, therefore, the tide at Tahiti may be summarized as "highwater, noon and midnight; low water, breakfast and supper." The local term, *tooerar-po* is used alike to express high water and midnight. And it is altogether likely that the tides served the easy-going Tahitians as a sufficiently satisfactory timepiece. When life is pleasant and unhurried what difference, really, does an hour or two make?

JOINT SOVEREIGNTY OF SUN AND MOON AT TAHITI

In the fact of the tide at Tahiti tending to come about the same time every day, the sun manifests its joint and equal sovereignty with the moon. But a regard for accuracy makes it necessary to emphasize the point that it is not *exactly* the same time but only *about* the same time that the tide comes. This emphasis is called for since in describing Tahiti the statement is frequently made that the tides here ebb and flow with unvarying regularity, never changing in time from one year's end to another. Indeed, a recent book quotes a mariner as saying that from the verandah of his club at Papeete he could tell the time of day within a quarter of an hour by looking seawards and seeing where the water stood!

We now have accurate information with regard to the tide at Tahiti for it has recently been carefully studied. At the instance of the U. S. Hydrographic Office, Mr. Harrison W. Smith of the Massachusetts Institute of Technology, sojourning in Tahiti, secured accurate tide observations for several years. These tide observations have been analyzed by the tidal mathematicians of the Coast and Geodetic Survey, and it was found that here the sun has approximately the same tidal effect as the moon.

At Tahiti therefore, the moon shares with the sun her sovereignty over the tide. And it is this fact that accounts



Tide curves, Tahiti, September 13–19, 1924. Height scale $\frac{1}{5}$ of nature

for the truancy of the tide. Compelled at the same time to pay equal homage to both sun and moon, the tide tries now to keep step with the moon, which tends to make it come later each day by fifty minutes, and now to follow the sun which labors to make it come

at the same time day after day. It thus wavers in its allegiance from one day to the next and ends by coming to high water about noon and midnight, and to low water about six o'clock both morning and evening.

CAUSE OF TIDE'S TRUANCY

In tracing the peculiar behavior of the tide at Tahiti to the joint and equal sovereignty of moon and sun, we have gone but one step towards the explanation of the truancy of the tide here. The question at once comes up, why this exceptional state of affairs in the tidal effects of sun and moon at Tahiti? The answer is found in a study of the wave movement with which the sea responds to the tide-producing forces of sun and moon.

It is a matter of every day experience that a body of water which is disturbed from its condition of rest tends to set up waves. A pebble dropped into the pond, the wind sweeping the surface of the lake, the boat propelled through the water—all these give rise to waves. And in the same way the tide-producing forces of moon and sun, acting upon the waters of the sea, bring about the slow but mighty wave which stirs the sea to its very depths and which we call, for short, the tide.

A body of water is capable, however, of sustaining two different kinds of waves. Suppose we take an oblong tank, say twenty feet long filled with water to a depth of about half a foot. By agitating the water at one end with a paddle we may start a wave which will advance or progress from one end of the tank to the other, the outline of this wave being the sinuous curve which we generally associate with wave movement.

But we may also set up in our tank of water a wave movement of an entirely different kind by raising and then immediately lowering one end of the tank. The water will then swash or oscillate alternately from one end of the tank to the other about an axis situated in the middle of the tank. And if we examine this type of wave movement carefully we will note that the rise and fall is practically nil at the axis and increases regularly toward the ends of the tank.

The more recent studies of the tide show that the tide wave of the open sea is of the oscillatory kind, the oscillation taking place about axes where the rise and fall of the tide obviously is small. Moreover it follows that the axes of the oscillation due to the moon's tide-producing forces do not coincide with those of the sun's tide-producing forces.

Here then we find the explanation of the truancy of the tide at Tahiti, for this island lies close to one of the axes of the oscillation due to the moon's tide-producing forces. The tidal effect of the moon is therefore small here—so small in fact, that the moon loses its predominant position of mistress of the tide, sun and moon playing equal rôles.

The Peruvian Guano Islands Seventy Years Ago

By ROBERT CUSHMAN MURPHY

Curator of Oceanic Birds, American Museum

NOW and again it happens that some perishable treasure of a bygone day is not only saved from oblivion but is dropped into the lap of the individual who, above all others, may comprehend and prize it. Once, at least, this has been my lot. If a connoisseur of Americana were invited to carry away from a dismantled house an unlisted, unrecognized copy of Denton's *New York* (1670), he could hardly feel a greater thrill of exultation than did I when a visitor entered my laboratory in the Museum and casually spread out the photographs reproduced on the following pages.

It would be rash to assume that no similar records of the climax in Peruvian guano traffic are in existence. For decades the fleet of square-riggers crowded about the Chinchas and other treasure islands, bringing crews from the United States and from nearly every seafaring country in Europe. Many a sailor of those years painted crude impressions of cliffs and huddled ships on bits of planking, a few of which have found their way into maritime museums. Photography was in its infancy, yet some of the wide-awake skippers who made repeated voyages to these rock-bound heaps of fertilizer must have sought means to secure objective records of the stirring, well-nigh incredible scenes that met their eyes. Indeed, the present photographs may prove the point. But where are others? Possibly in metal-hasped albums lying forgotten in old homes of New England or British seaports; possibly among the musty archives of the *Biblioteca Nacional* at Lima; we have no means of knowing, but it is safe to say that most of them have vanished utterly—no more to be sought than the priceless manuscripts of Alexandria which were burned by order of Omar in the year 641.

These photographs from the Chinchas, which were presented to the Museum by Mr. Walter R. Merryman, of Haverhill, Massachusetts, are prints of about seven by nine inches from negatives prepared by the old wet-plate process. The method came into vogue a few years after 1850, and, since it was necessary to sensitize the glass sheets immediately before their exposure and to develop them immediately afterward, a high degree of skill was required, as well as the transportation of such a quantity of impedimenta as would appall a modern film-pack enthusiast.

The pictures came into the possession of Mr. Merryman through two collateral forbears, one of whom, Captain Charles Spence Merriman, of Brunswick, Maine, died about 1872. Captain Merriman commanded the ship "Marcia Greenleaf," in which he is reported to have made several runs to the Chincha Islands. From the character of the prints, the residue of guano depicted on North Chincha, and the appearance and rig of the clustered vessels, it is possible to fix the date of the photographs as approximately 1860.

The wild story of the guano years, which Peruvian historians refer to as a "saturnalia," is not likely to be familiar to many American readers of

South Island of the Chinchas, October, 1919. The dark patches on top of the island are a great colony of cormorants. The topographic changes wrought by the removal of the guano beds may be seen by comparison with the old photograph on page 443. In the background twelve miles distant, is San Gallan Island

today. A sketch of the period, however, is to be found in *Bird Islands of Peru*,[1] in which the particularly vivid reminiscences of "The Chincha Islands Fifty Years Ago," by Dr. Frederic A. Lucas, honorary director of the American Museum, go far to reconstruct the Guano Age during the earlier years of its decadence. The death of the whole trade, and its phoenix-like rebirth under a newer and better régime, belong to another tale. For the moment our thoughts are turned back to a time when guano-fever burned as fiercely as ever did gold-fever, and when the Chinchas were a focus of greed and corruption, a forgotten center of dust-gagged misery and slavery as well as of important business ventures, eminently respectable, of course, and represented by calculating skippers and by ships with towering spars.

Aside from the evidence these photographs yield as to the amount of ancient guano that yet reposed upon the islands nearly seventy years ago, they are of exceptional interest as a record of contemporary shipping. Doctor Lucas and I have pored long over the fleets of more than thirty vessels revealed in the panoramas of North and Middle islands. The majority are American craft. Here and there lies a hull with painted ports that may be a degenerated British packet. The brig in the right foreground of the Middle Island view seems also to be an Englishman. The cumbersome deck-houses of two or three full-rigged ships stamp them as St. Johnsmen, from New Brunswick, and a small white bark, bearing an elaborate figurehead, may be French or Norwegian. But nine out of ten, perhaps, are Yankees—new or old, as indicated by their lines, the loftiness and rake of their masts, or the number of their topsail-yards. A few are close to the clipper type, while

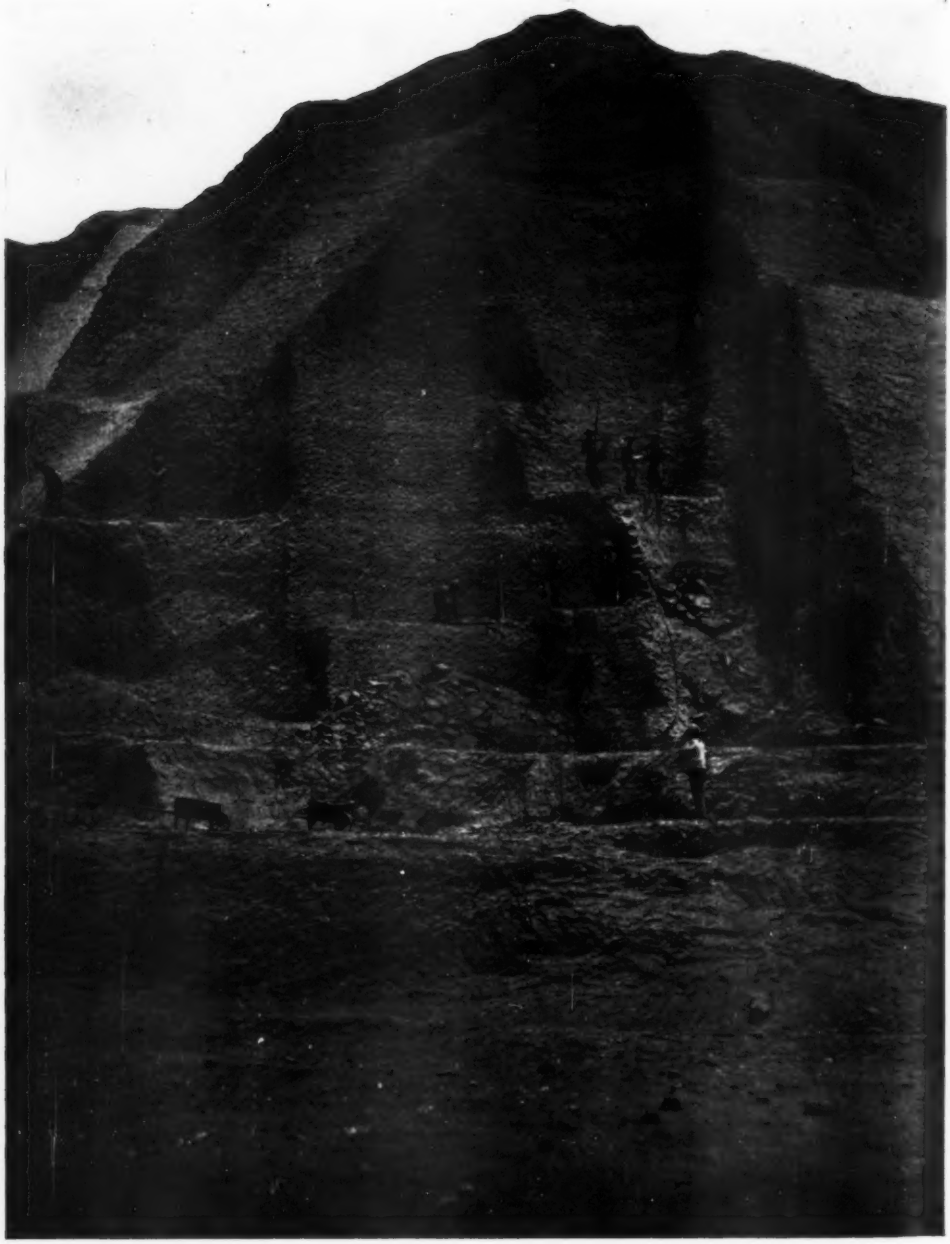
[1] *Bird Islands of Peru*, by Robert Cushman Murphy. Putnam, N. Y. and London, 1925. Reviewed in NATURAL HISTORY, Vol. XXV, No. 2, pp. 199–201.

others may have been launched before Old Ironsides left the ways.

What a picture these venerable windjammers make! Some are light, awaiting their turn, but others, such as the bluff-bowed ship moored to a shore-ring in the North Island view, are already well laden, with lighters alongside. Fast by bower and kedge, the staunch vessels rest in the North Strait, with awnings and windsails set for comfort. Careful skippers, with the prospect of a long delay, have unbent their canvas and, in some instances, have sent down their upper yards. What a galaxy of proud ship-masters within hail of each other! What courtesies and amenities exchanged each quiet tropical evening! For guano fetched ninety dollars a ton in Liverpool or Charleston, and, to skippers and crews life was a jolly song. It was not strictly necessary to heed the accompaniment to this song, rendered on the plateaus of the islands by coolies who sweated out their lives under the lashes of black drivers, or dashed themselves over the precipices into Lethe.

Sailor's trinket from the Lobos Islands, Peru. The bottled design, save for two ships drawn on paper, is made up wholly of guano and polychrome rock powder

Perhaps a few of the readers who scan these photographs may recall country stores in New England bearing the sign "West India Goods and Groceries." West India Goods were euphemistic words for rum and molasses, and the "groceries" always included small bags of Peruvian guano, stencilled with an unreal seafowl. Behold now the source of this magical, strong-smelling powder, and the wooden bottoms in which it was carried from the despoiled Chinchas to the ends of the earth.



GUANO CUTTINGS ON MIDDLE CHINCHA ISLAND

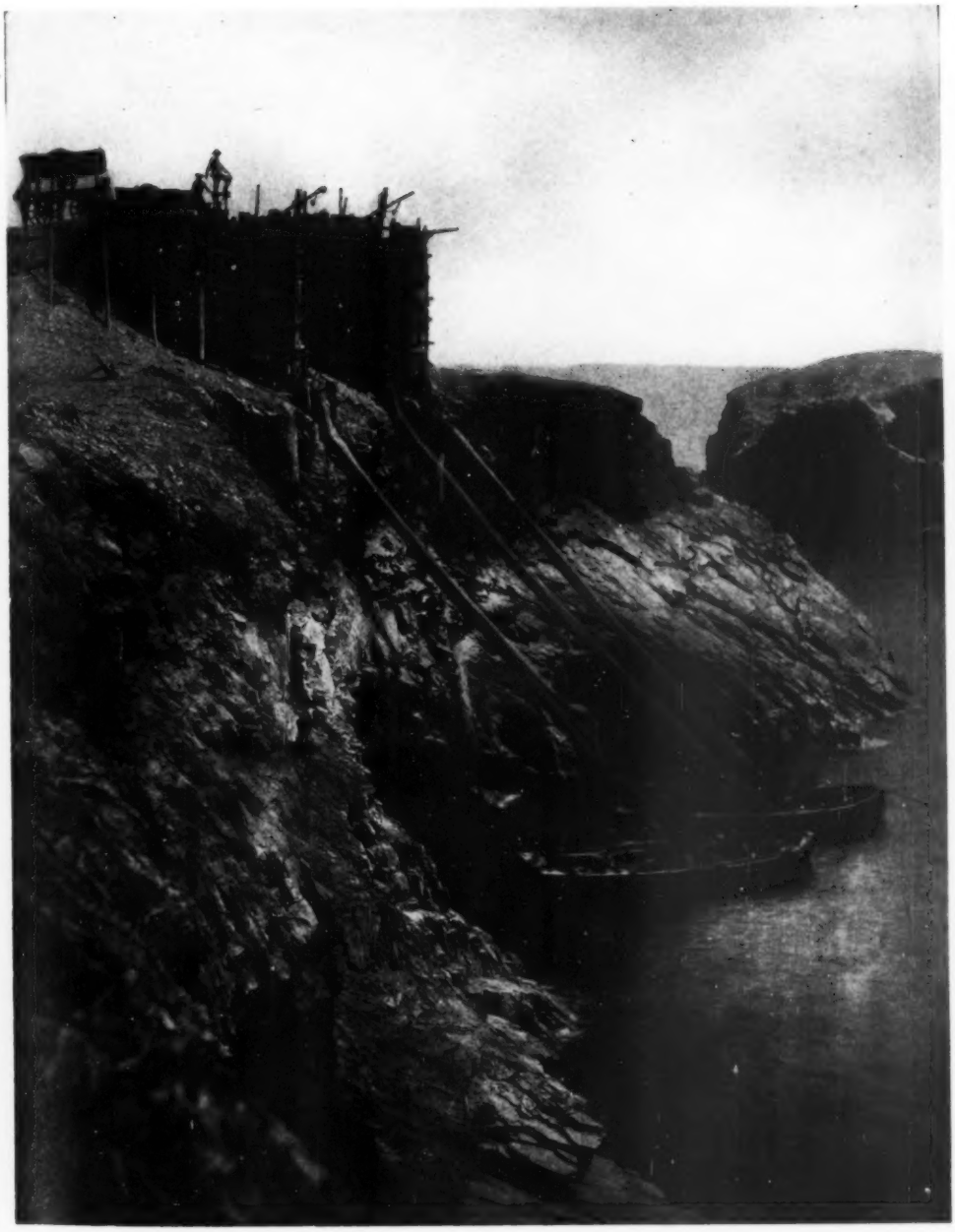
The thickness of these amazing beds, as estimated from the stature of the toiling coolies, is not less than sixty-five feet. The original insular deposits, which may be likened to glacial caps, were in some places more than a hundred feet deep, representing the accumulated droppings of myriad sea fowl throughout thousands of years

South Chincha Island, as seen across the strait from Middle Island. Excavation is here in a younger stage and the cut bank of the great mound of guano shows distinctly. Noteworthy among all these pictures is the apparent absence of the sea birds that were the sole producers of the treasure. Compare with the recent photograph on page 440.

Residual stacks of guano on Middle Chincha, showing stratified layers perhaps one hundred and twenty-five feet in height from bed-rock to the former level of the deposit. A Peruvian survey of 1853 computed the quantity of guano then lying on the three Chincha Islands to be 13,376,100 tons

A GUANO TOWN OF YORE

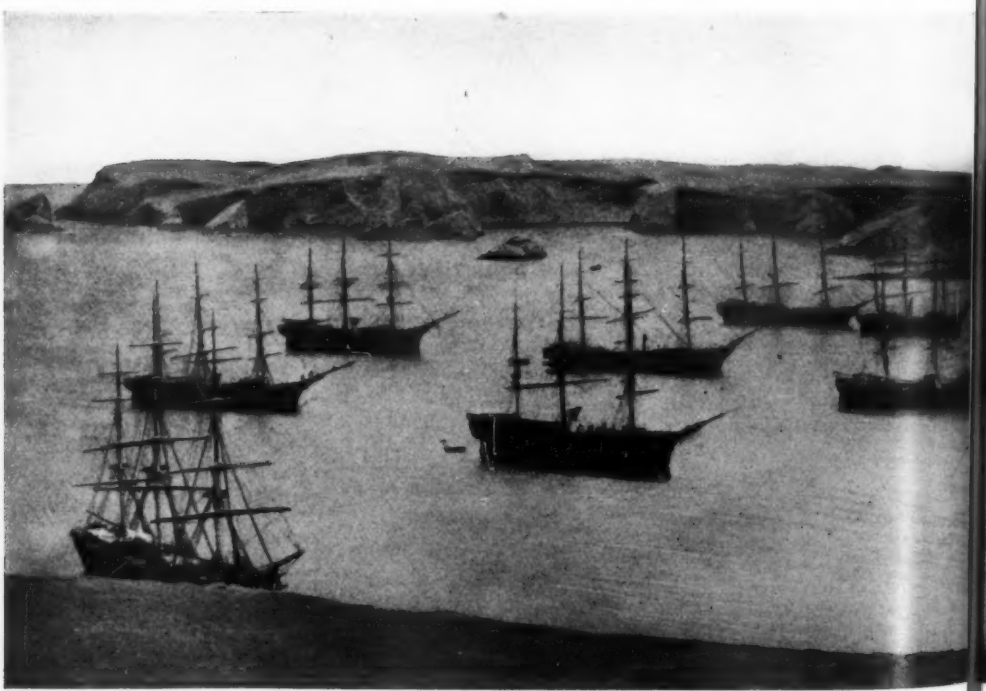
A corner of the "city" on North Chincha Island, of which not a trace now remains. Wooden chutes carried the fertilizer to box cars at lower levels from where, in turn, it was transported to cliffs above the anchorages



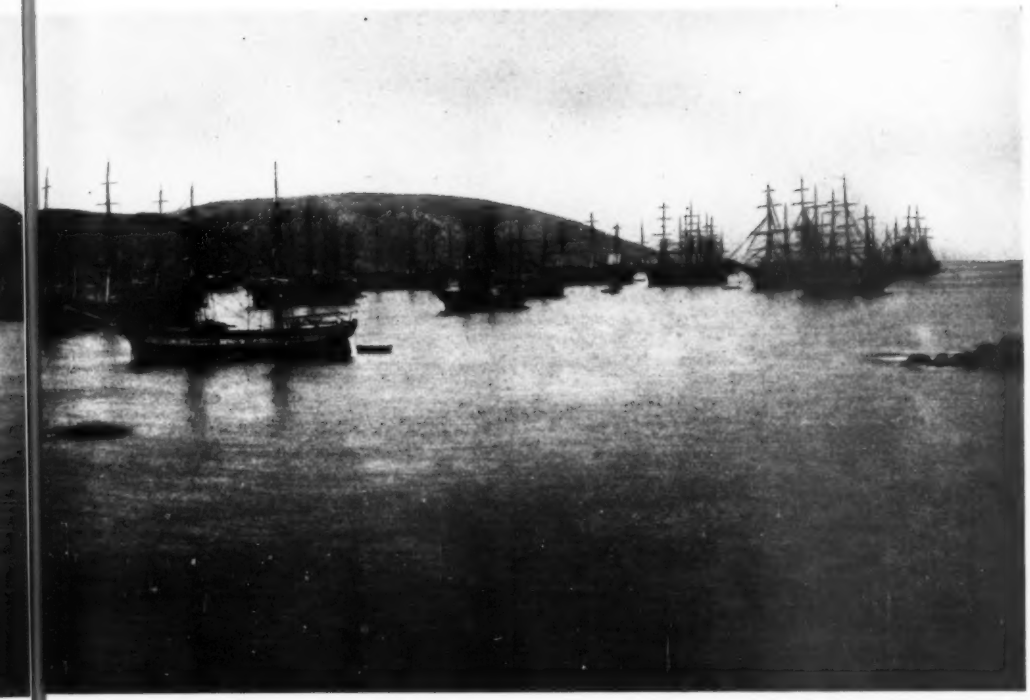
FILLING THE LIGHTERS

At the terminus of the railways the guano was dumped into enclosures, and subsequently shot through huge canvas hose to small craft beneath. Sometimes even the ships would be warped against the rocks to be loaded directly, and, it is said, within a space of three or four days

GUANO CARRIERS AT THEIR MOORINGS IN THE NORTH STRAIT, AS SEEN FROM



THE SAME FLEET AS VIEWED FROM THE BRINK OF THE CLIFF OF MIDDLE ISLAND



FROM NORTH ISLAND, WITH MIDDLE CHINCHA ISLAND IN THE BACKGROUND

ISLAND, WITH THE TOWN AND REMNANTS OF THE GUANO HEAPS ON NORTH ISLAND

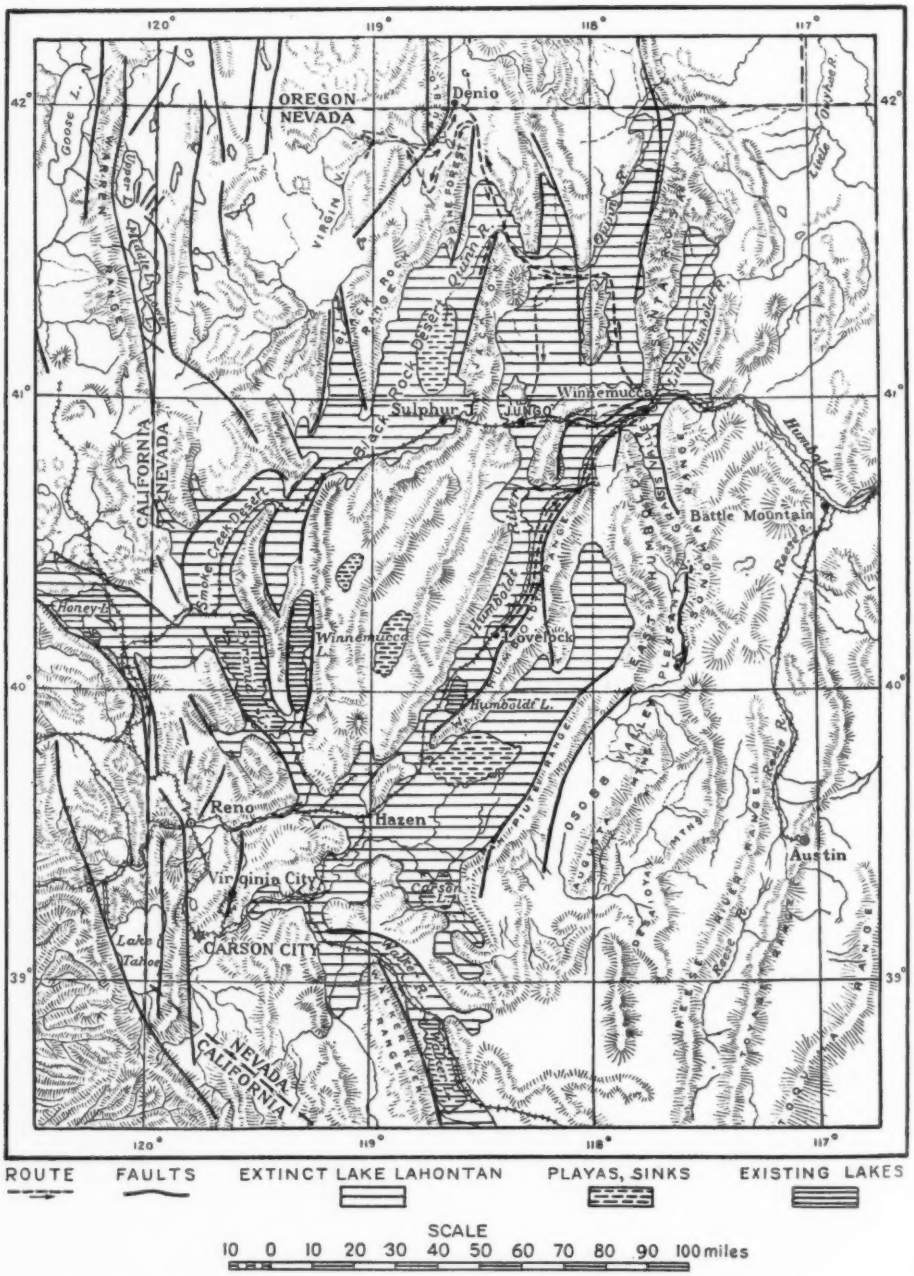


Fig. 1. Sketch map of northwestern Nevada showing the relative position of the uplifted mountains and depressed valleys, the pronounced fault lines, the former extent of Lake Lahontan and the existing lakes, playas and sinks, also the route taken by Dr. Chester A. Reeds and his party in May, 1927

Desert Landscapes of Northwestern Nevada

By CHESTER A. REEDS
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THE most striking feature of northwestern Nevada is its desert landscapes. These landscapes are not great barren wastes of drifting sand with only a dune to relieve the monotony of the horizon, as a person unacquainted with American deserts might suspect, but a region consisting of many mountain ranges, high plateaus, mesas, and extensive valleys, Fig. 1. In the clear air of the desert these features seem to be of much smaller dimensions than they really are. Many of the valleys have no outlet, since the lowest passes, from one to another, are oftentimes several hundred feet above the valley floor. If it were not for the minimum rainfall, scarcity of water vapor in the the atmosphere, and diminished amount of water on the surface of the ground and underground, the region would be a fertile country. Rivers and flowing streams are rare, springs few and far between, and water a commodity for which men search, often with life at stake. The desert climate is consequently of an exaggerated continental type.

The atmosphere of this immense region is dry, remarkably clear in winter, but filled in summer and during the period of equinoctial storms with minute particles of dust which produce extraordinary color effects. Radiation is intense and the temperature is subject to extremes, the annual range being about 124°. The daily variation is also great. The mean temperature for the winter months, December, January, and February is 26°, with extremes reported of 73° and −42°; the mean temperature for the summer, June, July, and August, is 69°, with extremes of 108° and 20°. The low humidity of summer prevents the heat from being oppressive and cases of sunstroke are unknown.

The rainfall is exceedingly light. It nowhere exceeds twelve inches, while the average annual rainfall varies from seven to eight inches. Some sections have no rain for several successive years. During the winter months, the precipitation is usually in the form of snow on the mountains, Fig. 5. Oftentimes a considerable fall of snow covers the mountain tops in May. The melting of the mountain snows in the spring causes severe freshets, which in turn are followed by long seasons of drought at a time when water is most needed for agricultural purposes. Fogs and hail are rare, but cloud-bursts are not uncommon.

Two railroads, the Southern Pacific and Western Pacific, have been built across northwestern Nevada, and except for the towns along these routes and the various mining camps, the region is sparsely settled; in fact, ranch houses have been built only where mountain streams debouch upon the desert plains, and then only where the supply of water is sufficient to afford two separate waterings of the land under irrigation, Fig. 2. Except for an occasional garden, attention is given almost exclusively to the raising of wild grass or alfalfa with which to feed live stock, chiefly cattle and sheep, during the winter months. Graded state and national highways

Fig. 2. View looking northwest across the Black Rock Desert; in the foreground an ex-cowboy may be seen irrigating an alfalfa field on the Steele ranch. Water for this purpose is taken from Jackson Creek, a snow-fed mountain stream, which debouches on the valley plain a half mile east of the spot shown

Fig. 3. A portion of the western face of the Jackson Mountains. View looking southeast from the edge of the Black Rock Desert in the vicinity of Jackson Creek and the Steele ranch. A bowlder-strewn alluvial fan appears in the foreground and mid-distance, also some rabbit-brush; in the back ground may be seen the dissected mountains with short stream valleys normal to the front, and a fault scarp with two prominently exposed faces, which runs parallel to the edge of the mountains

have been built across this section of the State to accommodate the ever increasing automobile traffic, but these routes are few, and the outlying districts are still served by dirt roads and trails, which during the spring months are frequently too soft, too crooked, too steep, or too much washed out to afford pleasure in driving a car over them.

In May, 1927, while traveling from Lovelock, Nevada, to Jackson Creek in the Jackson Mountains and northward to the Virgin and Thousand Creek valleys, which appear southwest of Denio, Oregon, Fig. 1, the writer had an opportunity to observe closely the variable features of this remarkable desert. This exploring trip was made possible through the courtesy of Mr. J. P. Morgan of New York. In the field the writer was accompanied by Mr. Carter L. Loth of Staunton, Virginia, and Mr. John T. Reid and

Fig. 4. The rock-strewn delta and depressed narrow channel of Jackson Creek, western margin of the Jackson Mountains, Nevada. View looking northeast from the Black Rock Desert

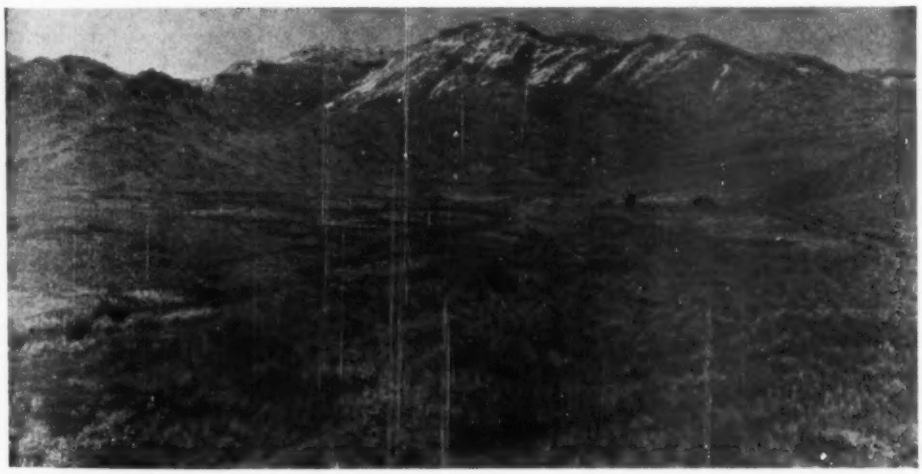


Fig. 5. The upper course of Jackson Creek; a broad flat mountain valley containing a few stunted trees and many thousands of desert shrubs

Captain A. H. Scott of Lovelock, Nevada.

The region is of intense interest to the geologist, since it is formed of innumerable faulted crust blocks, the elevated ones constituting the north and south mountain ranges, and the depressed ones the valleys that lie between. The treeless ranges have bases from five to twenty miles wide, while the intermontane valleys are of about the same width. The elevation of the valleys above the sea is approximately 4000 feet, while that of the mountains is from 1000 to 6000 feet higher.

The uplifted and tilted earth blocks have many pronounced characters in

Fig. 6. Fault scarp along the western margin of the Sonoma Range, the development of which produced the Pleasant Valley earthquake of October 2, 1915. Photographed by P. Blanchard of Kennedy, Nevada.

Fig. 7. Near view of the recent fault scarp at the base of the Sonoma Range, and a mountain stream tumbling down over it. Photographed by P. Blanchard of Kennedy, Nevada, following the Pleasant Valley earthquake of October 2, 1915

common. They show no outlying foothills, no mountain spurs or lobes passing out into the valley plains, Fig. 3, and no flat baylike valleys extending into the ranges, all of which indicates that they are not residual mountains, resulting from protracted erosion. The steeper slopes of the ranges, Fig. 3, aside from alluvial cones and sediment aprons, Figs. 3 and 4, are limited by a sinuous base line at the margin of the valley plain. Furthermore, the short mountain streams leave the ranges practically normal to the mountain front, and not longitudinally along the structure of the bed-rock as in adjusted streams. Those that leave on the steeper side of the mountain ranges often show a more youthful condition in their lower course, Fig. 4, than in their upper portions, Fig. 5. This suggests a progressive series of uplift movements along the marginal fault line in recent time. Fault scarps of recent date, Figs. 3 and 6, with vertical displacements varying from 10 to 50 or more feet can be traced along a considerable length of many of the mountain ranges as noted by the heavy black lines on the sketch map, Fig. 1.

The most recent displacement along a fault, which was also the *locii* of a severe earthquake, occurred on October 2, 1915, along the eastern margin of Pleasant Valley, Nevada, Fig. 1. Two fore-shocks and a large number of after shocks accompanied this disturbance: The first fore-shock of about 10 seconds' duration came at 3:41 P.M., the second fore-shock which lasted half a minute began at 5:49 P.M., while the principal shock occurred at 10:54 P.M., and lasted for about a minute. These shocks produced the slipping along the fault scarp noted in Figs. 6 and 7, which were taken by Mr. P. Blanchard of Kennedy, Nevada, a short time after the quake occurred. These views were forwarded to the writer by Mr. John T. Reid of Lovelock, Nevada. The sinuous fault line, which is still evident, extends for twenty-one miles along the western margin of the Sono-

ma range, as noted in Fig. 1. Of the twenty-five or thirty people that inhabited the region at the time no one was injured; however, several stone ranch houses and barns near the line of the fault were completely demolished. The shocks were felt within a radius of seven hundred miles of the fault.

It is reported that, following the earthquake, streams of water came into existence where there was no water before, and at other places where there were springs the water ceased to flow. Near the fault and in numerous places within a hundred miles of the disturbance a great increase of water was observed, Fig. 7. In some instances the flow has returned to normal, while in other places the larger flow still continues.

Excellent records of this severe earthquake were obtained at many of the seismograph stations in the United States and Canada. The record of the north-south component of the seismograph at the American Museum is reproduced as Fig. 8. It is interesting to note that the fore-shocks as well as the main shock are recorded. Since there is more than three hours difference in time between New York and Nevada this fact should be considered in comparing the record with the field data.

In Pleasant Valley it is reported that the principal shock lasted one minute; on the seismograph record, Fig. 8, it may be noted that the recording of the quake took slightly more than an hour. This is due to the fact that the waves set up in the earth by the disturbance are of various kinds and have different speeds and routes. The fastest waves, which take the shorter route through the earth, are recorded first. The slower waves that follow the surface of the earth are recorded later.

This earthquake along the western margin of the Sonoma range is typical of the disturbances that have arisen in comparatively recent geological time, along the numerous faults noted on Fig. 1, which occur on one side or the other of the block mountain ranges of northwestern Nevada. The pronounced fault scarps on the westerly side of the Jackson

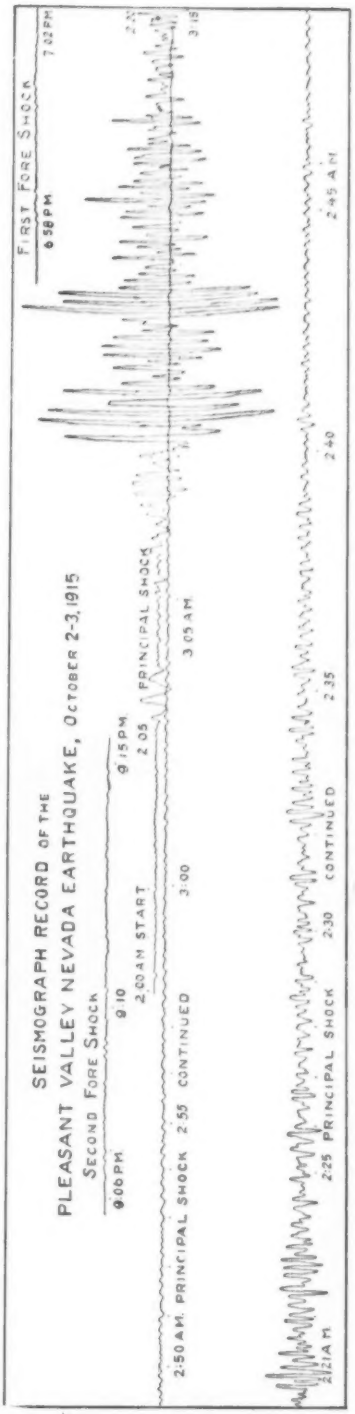


Fig. 8. Instrumental record of the Pleasant Valley, Nevada. earthquake of October 2, 1915, made by the seismograph at the American Museum of Natural History, New York

Fig. 9. A shallow mud lake, the terminus of the Thousand Creek valley of northwestern Nevada. View taken nine miles southwest of Denio, Oregon. In the foreground may be seen some desert shrubs and a huge block of lava, which has broken loose from the Pueblo Mountain escarpment, shown in Fig. 19. The northern end of the Pine Forest range appears across the lake with two low volcanic cones near the center of the picture

Fig. 10. A dried mud lake surrounding Jungo, Nevada. The sun-cracked level surface is conspicuous in the foreground; in the mid-distance a mirage, represented by the dark line in the photograph, gives a vivid impression of the vanished water; in the background the Donna Schee mountains on the left with an elevation of 5200 feet, and the Slumbering Hills on the right, with altitudes of 6400 feet, add variety to the landscape. View looking northeast from Jungo, Nevada, May 14, 1927

Mountains, Fig. 3, led the writer to enter this fault line on the map, Fig. 1.

The great valleys of northwestern Nevada are generally level-floored and most of them represent the bed of a great inland lake of Pleistocene age known as Lake Lahontan, which has disappeared for the most part. The maximum extent of this lake as traced by Russell in 1885 has been entered on the sketch map, Fig. 1. Some of the deepest depressions of such a body of water are yet marked by Walker, Humboldt, Carson, Pyramid, and Winnemucca lakes, Fig. 1, which are fed by rivers and are perennial; others, which are intermittent, are represented by sinks, mud lakes, and playas, Figs. 9 and 10. These lakes are for the most part salty or brackish and the latter group evaporate when the supply of water fails.

The largest of the mud lakes occurs in the Black Rock Desert on the western side of the Jackson Mountain Range. At times it is several hundred

Fig. 11. A near view of the white "alkali flats" of the Black Rock Desert. In May the ground was still soft and wet from the snow-fed waters of Jackson Creek and Quinn River. In the distance the Black Rock Range, some twenty miles away, is faintly outlined

Fig. 12. A. H. Scott, C. L. Loth and J. T. Reid, eating luncheon at a roadside spring on the desert eleven miles northwest of the Quinn River crossing. The waters of this spring, which are hot, with a temperature of 130°, contain a small amount of sulphur and other minerals. Chalcedony, the hard rock that appears near by, is deposited by the spring waters. In bygone days the Indians oftentimes camped for months in the vicinity of the spring for they found that the waters possessed medicinal values

miles in length and only a few inches deep. It is fed for the most part by Quinn River and its tributaries. In the spring the ground is soft and marshy; in the summer time when the waters evaporate they leave a clay bed which dries hard and, over large areas, is encrusted with saline matter of such whiteness that it dazzles the eyes of the traveler, Fig. 11. These white beds are known as "alkali flats." Sun cracks and mirages are not uncommon on the surface of these dry lake beds, Fig. 10.

On the margins and sometimes on the floor of these desert basins occur large springs, some cold and some hot, many of which are surrounded with deposits or incrustations of mineral matter, frequently chalcedony, Fig. 12.

Fig. 13. A view of Lone Mountain near Lovelock, Nevada, from the tufa deposits a mile to the northwest. Several shore line terraces developed by the receding water of former Lake Lahontan appear on the slopes of this mountain. The floor of the old lake with its sand, gravel and tufa deposits and desert vegetation appear in the foreground

Fig. 14. Numerous stacks of calcareous tufa deposited in old Lake Lahontan occupy the top of a gravelly ridge three miles northwest of Lovelock, Nevada. Algæ and bacteria secreted this material from the saline lake waters and deposited it locally as tufa

One of the various localities where the ancient shore lines of Lake Lahontan appear well preserved is on the face of Lone Mountain two miles to the west of Lovelock, Fig. 13. This mountain has an elevation of 4650 feet above the sea and 650 feet above the alluvial plain of the Humboldt River. It has a base consisting of granite and hornfels and is overlaid in turn by volcanic tuffs and rhyolite. The tuff and lava caps dip to the northeast beneath the valley floor. At an elevation of 300 feet above the surrounding plain the east face and north end of the mountain are notched with a deep wave-cut terrace and bold cliff etched by the former waters of Lake Lahontan. Due to the northeastward inclination of the volcanic rocks, the wave-cut terrace rests in part upon the granite, at the south, and in part upon the tuff and rhyolite, at the north.

A mile to the northeast of Lone Mountain numerous stacks of calcareous tufa extending northeast-southwest, stand upon a gravelly ridge, Fig. 14. As noted by the hand-level, they have approximately the same elevation as one of the wave-cut terraces on the face of Lone Mountain. One of the stacks has an eagle's nest on top of it, Fig. 15. In 1885, Rus-

sell[1] recognized three types of calcareous tufa in the Lahontan Basin: namely, the lithoid, stony and compact; the dendritic, porous and coralline; and the thinolite, crystallized and a pseudomorph after an unknown mineral. He reports that these tufa deposits appear in succession above the present level of Pyramid Lake with the lithoid at the base, succeeded by the thinolite, and the dendritic covering the two.

Recently, J. C. Jones[2] observed that the tufa deposits forming at present in the Salton Sea were being deposited locally through the activities of plant life, that is, blue-green algæ and the bacteria associated with them. He concluded that, since the Salton Sea waters, which are depositing dendritic tufa, contain ten times more calcium carbonate than Lake Pyramid waters, which contain only one-twentieth of the amount of calcium possible and are depositing only lithoid tufa, the calcium content of the lake waters is a determining factor in the type of tufa formed. He also concluded from various experiments with Pyramid Lake waters, that the thinolite was deposited as aragonite at a time when the waters of Lahontan were saturated with calcium carbonate. A fine specimen of the tufa with thinolite growths in the center, which was presented to the writer for the American Museum by Mr. Reid, appears as Fig. 16.

The flora of northwest Nevada is of a peculiar type, Fig. 17. With the exception of the alkali flats, no portion of the desert is devoid of vegetation. Scattered trees, such as the piñon and the juniper, appear along the mountain streams at an altitude between 5000 and 7000 feet, but they rarely reach a height of 15

Fig. 15. Near view of a calcareous tufa stack with an eagle's nest on top, three miles northwest of Lovelock, Nevada. C. H. Jones, C. L. Loth, and J. T. Reid are making an inspection

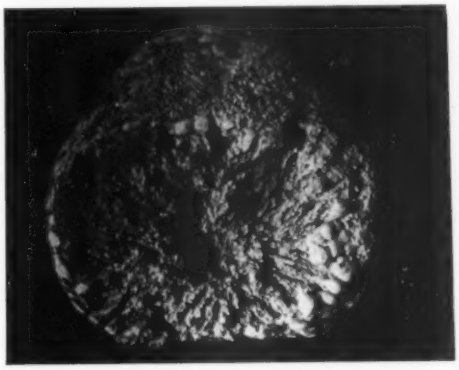


Fig. 16. Top view of a globular cup-shaped mass of calcareous tufa from three miles northwest of Lovelock, Nevada. Three varieties of the tufa are shown: The lithoid on the margin, the dendritic and thinolitic within the cup. This specimen which is 15 inches in diameter was presented to the writer for the Museum collections by Mr. John T. Reid of Lovelock, Nevada

[1]Russell, I. C., 1885. Monograph No. 11, U. S. Geological Survey.

[2]Jones, J. C., 1914. Publ. 193, Carnegie Inst. pp. 79-83.

Fig. 17. A desert landscape in the Jackson Mountains, Nevada. In the right foreground may be seen the more luxuriant growths of rabbit-brush on the banks of Jackson Creek; in the left foreground a hay stack of bunch grass; in the background sage brush and other kindred plants cover the slopes of the mountains and the tributary valley

feet, Fig. 5. Several varieties of poplar, alder, and willow are also found in the cañons, but these trees as a rule are of slow growth, knotty, and ill-adapted for timber. On the foothills are found phlox and lupine, and in the mountain valleys bunch grass which is valuable for grazing purposes.

The great valleys are treeless, but they are covered with desert shrubs. Greasewood (*Sarcobatus vermiculatus*), creosote bushes (*Larrea tridentata*), sage brush (*Artemesia tridentata*), rabbit-brush (*Chrysothamnus nauseosus*), shad-scale and "Humboldt tea" are the more common species.

The most striking of the various desert landscapes that were seen in northwestern Nevada were those to the southwest of Denio, Oregon, in the vicinity of the Thousand Creek valley and Virgin valley. In some places, successive flows of lava appear one above the other with such regularity that they resemble inclined stratified marine beds as in the Pueblo range, Fig. 18. In other places they form great table-lands, Fig. 19, or cap mesas, Fig. 20. The Thousand Creek valley, Fig. 19, is a depressed crust block whose southern margin is bounded by an Eocene rhyolitic lava that stands some 700 feet higher than the floor of the valley. This escarpment of Fig. 19 as well as the cliff face of the Pueblo range, Fig. 18, represent great fault scarps. The northern margin of the Thousand Creek valley is quite unlike the southern margin in that it is irregularly indented and the various lava flows appear at different elevations, the oldest at the top with the younger flows occupying old erosion channels at successively lower levels. The most striking instance of this kind is "railroad ridge" some seven miles long, which rests on a stream bed deposit about 200 feet above the present floor of the valley. Fossil bones of horses, camels, lions, and mastodons have been found in the Thousand Creek valley sediments, which according to

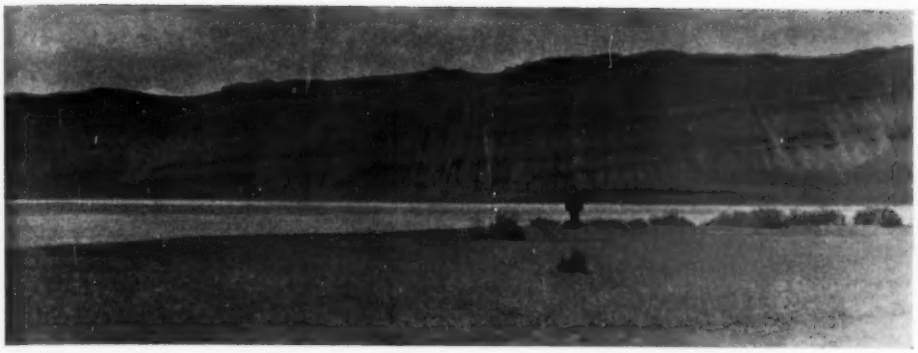


Fig. 18. View showing the eastwardly facing fault scarp of the Pueblo Range. The successive flows of rhyolitic lava, ash beds and tuff appear so regular that they resemble marine stratified beds. View looking west from the floor of a mud lake nine miles southwest of Denio, Oregon

Fig. 19. View looking east across the Thousand Creek valley. On the right appears an old flow of rhyolitic lava of probable Eocene age which is separated from the valley floor by a fault scarp some 700 feet in height. The tip of "railroad ridge" a more recent flow of lava appears in the left margin, while the Pine Forest range may be seen in the distance

Fig. 20. View looking south across the valleys of Beard Creek and Virgin Creek, Nevada, 28 miles southwest of Denio, Oregon. In the foreground appear the ranch house and barns of Mr. Thomas Dufurrena; in the mid-distance the weathered slopes of the soft Virgin Valley beds, and in the background the lava-capped mesas, which are a conspicuous feature of this volcanic region

Fig. 21. Near view of some of the opal mines in the Virgin Valley beds. The hills are barren of even the more common desert plants

Fig. 22. A large silicified tree trunk of Miocene in the Virgin Valley beds near Beard Creek, northwestern Nevada. The trunk is five feet in diameter and exposed for forty-two feet. The annual rings, which are well preserved, resemble those of the living Sequoia trees of California. From left to right Messrs. C. L. Loth, J. Lubbinga, A. H. Scott, and J. T. Reid

Dr. J. C. Merriam,[1] suggest a desert fauna of Miocene age.

Virgin Creek and Beard Creek, which form the headwaters of Thousand Creek, and lie to the south and west of the old flow of rhyolite shown in Fig. 19, have eroded deep valleys in the soft synclinally folded strata consisting of volcanic mud flows, carbonaceous sediments and volcanic ash deposits, known as the Virgin valley beds, Figs. 20 and 21. These beds contain fossil bones of horses, camels, rhinoceros, and many trunks of fossil trees, some of great size, Fig. 22. The Virgin valley beds are overlaid by extensive and horizontally disposed sheets of lava except where the streams have removed them. The yellowish volcanic muds, which buried

[1]Merriam, J. C., 1911. Bull. Dept. Geology, University of California, Vol. VI.

the great trees and animal life of this region in late Miocene time, contain many fiery opals. Some of the fossil trees contain opal, and it is due to this fact that many of the fine specimens of this petrified forest have been shattered by the prospector's sledge. Since opals crack readily with sudden changes of temperature, the better specimens, which occur as globules oftentimes as large as a man's fist, are obtained by mining below the frost line, Fig. 21.

Various portions of the Humboldt River valley, particularly to the northwest of Lovelock, Nevada, also contain fossil trees. A fine specimen which resembles a *Sequoia* was presented to the writer for the American Museum collection by Mr. George Stoker of Lovelock, Nevada.

The landscapes in the vicinity of these fossil trees of large size are barren desert wastes now, but the specimens indicate that the region has not always been so arid. The presence and great extent of Lake Lahontan, which is believed by some to have been contemporaneous with the various glacial stages of the Pleistocene epoch, suggest that the climate was formerly more humid. The extensive deposits of tufa and saline beds, are interpreted as representing periods of dessication. The variable character of the sediments, which cover the floors of the intermontane valleys and consist of alternating beds of lacustrine and fluviatile material, suggests recurrent waves of humidity and aridity. The numerous fault scarps on the margin of the mountain ranges, some of recent age, indicate that the region is being slowly uplifted. The geologic history of the Colorado River and its great cañon in southeastern Nevada, also confirm the general uplift of the Great Basin. As the region is elevated to greater heights, particularly the Sierra Nevada Mountains, which now intercept the moisture-laden clouds from the Pacific Ocean, a more extreme condition of aridity will arise. The present vegetation will then slowly disappear and the desert landscapes of northwestern Nevada will assume even a more desolate character, unless peradventure, for reasons yet unknown, a moister climate should return.

A HAZARDOUS TRAIL

Although much work has been put on these trails in time past, at present they are in bad condition, and only a Chinese load bearer would have the patience or endurance to carry heavy loads over them

Frog Hunting in Fukien, China

By CLIFFORD H. POPE
Herpetologist, Central Asiatic Expeditions

FOREWORD.—Contrary to popular belief, the efforts of the Central Asiatic Expeditions are not confined to collecting fossils, but include work on recent as well as fossilized vertebrates, not from Mongolia alone but from all parts of China. Early in January, 1925, Clifford Pope returned to China to continue his work with the Expedition as assistant in zoölogy. He collected recent reptiles, amphibians, fishes, and mammals. During the latter months of 1925 and nearly all of 1926, he remained in Fukien Province, making his headquarters at Foochow.

In the following article Mr. Pope tells many interesting things about the habits of Chinese frogs, and relates amusing encounters with the country people who so willingly helped him at every turn.

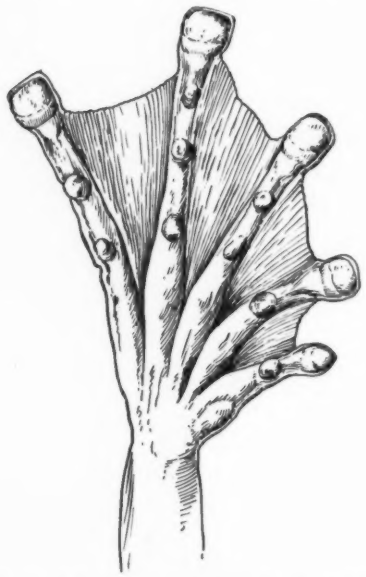
Mr. Pope wishes to express a debt of gratitude to Mrs. Lydia A. Wilkinson of Foochow, who not only made him feel so much at ease in her home, but generously offered her spacious back yard as a place to sun and repack hundreds of smelly specimens. To Dr. and Mrs. C. G. Trimble of Yenping he also wishes to express his appreciation for all they did to facilitate his work in the Yenping district.

TWENTY varieties of Chinese frogs "pickled" and stored away in museum jars make a tragic and hopelessly homogeneous assortment. These same twenty frogs alive in the wild forests and giant bamboo groves of South China assume a most fascinating aspect.

Take for example their voices. The giant green tree frog, *Polypedates dennysi*, which measures a good ten inches with outstretched legs, has a clear, liquid flute note beautiful in quality and volume, while its smaller brown cousin, *Polypedates leucomystax*, merely clucks like a hen. The green-backed frog, *Rana graminea*, denizen of the foaming mountain torrent, sends forth a variety of notes suggestive of a lot of young birds just learning to sing. A third tree frog, an unidentified *Rana*, has a long, trilled whistle, the last few notes of which, in contrast to the jazzy beginning, are so mournful that they make one feel despondent. Why this sorrowful ending to so lively a beginning? The pygmy of the lot, a typical *Microhyla*, scarcely an inch in length, from its retreat in the high grass bordering the rice fields, produces a sound like that of a whirling rattle in the hands of an energetic child. Then there is the mystery frog, the one we failed to hear but of which we were told so much. According to the Chinese, it calls only in the tenth moon of the lunar calendar and its call is so deep and full that, at first hearing it, one is startled. Stranger still, it is said that back of each eye it has a horn. We were not fortunate enough to secure an adult individual of this species.

It is not in voice alone that these amphibians show their individuality, for each kind occupies its own particular niche in the general mountain environment. The musical notes of the great green tree frog generally come from a clump of bushes or a low tree. The little brown one has adapted itself to a condition brought about through the Chinese fondness for rice. To grow rice it is necessary to flood fields, and in order to flood mountain fields, terraces must be constructed. These terraces would not hold were they not provided with

rock-work faces. In this rock-work there are countless cavities and, in the evening, issuing from these cavities, incessant clucking may be heard. Each frog selects a likely cavity and



The "sole" of the giant tree frog's webbed foot. There is often a striking likeness between the feet of semi-aquatic and aboreal frogs as both of them must cling to smooth surfaces. The diagram shows clearly not only the large cushions, one on the end of each toe, but also the smaller ones ranged along the toes. The terminal pads, or cushions, secrete a substance that keeps them from drying and thus enables them to retain a surface hardly to be called "sticky ' but much like the face of a non-skid rubber friction cap

there it lives, retreating to great depths in the day, but coming to the mouth after dark. It is in the spring that the fields are flooded for the setting out of rice and it is in the spring that these frogs lay their eggs. They have only to deposit them anywhere in the grass and weeds growing on the faces of the terraces and, when the tadpoles develop sufficiently, they have but to drop into the water provided so generously below. Before the Chinese arrived on the scene with their rice culture where did these frogs live and how did they breed?

Late one cloudy afternoon, after a disappointing day, I was climbing over some great bowlders under which a rushing stream made its way down the steep, forested mountain-side. Suddenly the silence was broken by a deep, resonant sound, hard to describe but known to me as the call of the giant *Rana spinosa* so common in these shaded cascades. I was thrilled, for it had come from under the very rock on which I stood. Dropping to my knees, in an instant I had thrust my arm and hand into the cavity under the bowlder. My excitement soon reached a far higher pitch for, instead of a frog, I felt a velvety mass covering completely the bottom of the rock. It did not take long to dislodge a section of this mass. There in my hand lay three objects, each one a perfectly transparent ball the size of a marble with an object as large as a BB shot, dark at one end and light at the other, apparently floating in its center. Like three masses of jelly they rolled about, changing their shape as they moved. It was quite impossible to pick them up. The frog had literally called me to its home, thus revealing to me its life secrets, secrets never before known to science. Further examination showed that there were not only hundreds of the transparent balls hanging from the submerged surface of the bowlder, but that they were held in place by strings of elastic mucous so that the swiftest flood was powerless to wash them away. Each egg was protected by two sacks, one close-fitting, little larger than the egg itself, the other many times larger and filled with a clear fluid. How

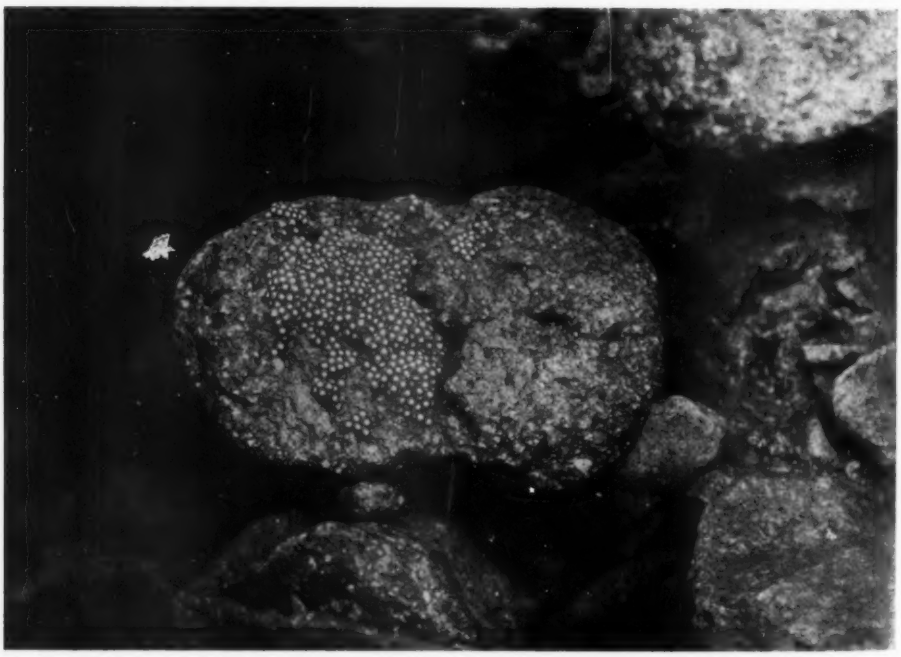
could this frog, itself but little bigger than a man's fist, be responsible for this great mass of eggs? The explanation lies in the nature of the clear protective substance, which not only has the power of adhering tenaciously to the smooth surface of wet rock and of stretching and resisting water like the best rubber, but also of swelling to enormous size upon absorbing and retaining quantities of water. The egg so delicate and fragile and yet so full of that marvelous potential energy that causes it to grow from a tiny mass of comparatively homogeneous matter into a highly complex organism, is thus protected. At certain early stages the slightest jar or pressure would destroy it, and yet the parent frog and nature work together to place it where the raging of storms, the rushing of foaming floods, heat from a tropical sun, or days of cold drizzle cannot interfere with its development.

Quickly gathering a few of the eggs, I climbed down the stream bed, soon reaching the place where it emerged from the forests of the steep mountainside to continue its course through the open, cultivated valley, now an unbroken expanse of flooded rice fields. Thus was I brought back to the realization that I was in China.

It did not take long to reach camp, which in this case happened to be a temple astonishingly perched on the steep side of our forested cañon. It would be useless to attempt to describe the scene that I looked out upon from this temple camp. I often envied the grim idols that had only to repose there, gaze out upon the forested cliffs and white waterfalls plunging into the depths of the cañon on every side, and accept food offered at regular intervals by worshippers weary from days of toiling up mountain trails. The cañon was one of the deepest I had ever seen; its

Each individual egg seen fastened to this upturned stone is enclosed in a mucous sack which adheres tenaciously to the surface of the rock, thus enabling the eggs to resist the pull of the current

Yu Fa, my star collector, hunted half a day before he turned up this stone with the eggs on it and subsequently received the reward of a fifty-cent dollar



In strong contrast to the eggs shown on page 465, these, also embedded in mucous, are attached in a mass instead of singly, illustrating another amphibian adaptation to breeding in swift water

Da da, shooter of more than a dozen tigers, is seated on the rock behind. To the left stands Young Tang, reptile and amphibian preparer. Fu Tuan, the cook, is in front at the right, while Old Tang, the taxidermist, sits next to him. Trapper Ah May squats like a Buddha

sides were almost perpendicular, their upper parts being sheer walls of rock. Lower down were forested cliffs frequented by serow, deer, leopards, and many other wild animals.

I had traveled all the way from the American Museum to China to collect animals and study their habits. A trip of five weeks' duration, beginning in luxury on the extra-fare train out of New York and ending in a tramp along a narrow stone trail leading up the cañon to this temple, had put us in the heart of a country with a fauna of great variety and special biological interest.

This interest lies in the geographical location of Fukien Province which we had picked out as our field, and which is known to the West chiefly as the home of the best Chinese teas. Situated midway between Canton and Shanghai, this region refutes the popular conception of China Proper as a flat country densely populated, for here, less than two hundred miles from the coast, is a wild mountainous district very sparsely settled. Moreover, Fukien occupies an area intermediate between tropical and temperate zones, and its fauna, therefore, contains many elements from both climes. Abundant mountains and forests help to augment this profusion of wild life and materially increase the naturalist's interest.

With an appreciation of the wonder and beauty of nature peculiar to this race of nature-worshippers, the Chinese had built this temple in a place appropriate in more than one way, for in China a wild, secluded mountain retreat is generally picked out as a suitable locality for a place of worship. This temple therefore was an ideal camping site for a collector.

Experience had taught me that one could secure large quantities of all the common reptiles and amphibians by enlisting the services of the country

Frog-catching equipment.—At one end of the rod is a little iron basket upon which pine knots are piled and lighted when the hunter is out frogging. The basket of "fat pine" is on his back. Note frog in left hand

This man was "boss" of a gang of tea pickers but he used to do collecting on the side. He is standing on a platform used for drying tea

people, who are only too glad to earn a little extra money catching snakes, lizards, and frogs everywhere so abundant. After stopping in a new locality it was only necessary to advertise for specimens. I had sent out notice and some were already being brought in. By using this method I was able to conserve my own time for special observation on the life histories of the more striking forms. Nearly every country lad has a business eye, and is not to be trifled with. A small boy, after hearing that we also wanted frog eggs, led me to a flooded field in which were many dozens. Unfortunately they turned out to be a kind already collected so I had to refuse them. After walking a few steps from the field I missed the boy and looked back to see him carefully treading the eggs in the mud one at a time! He was not going to allow himself to be fooled by any foreigner.

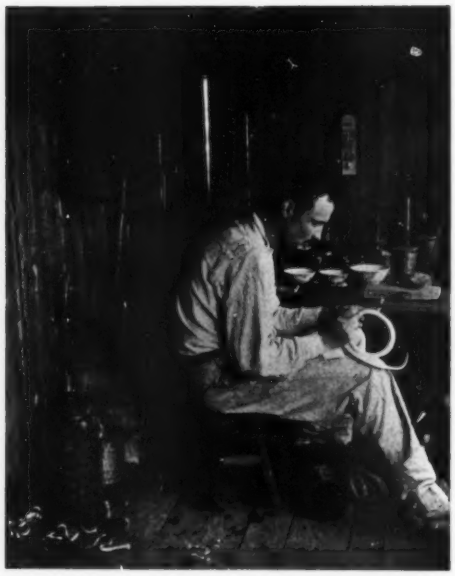
The temple keeper, a picturesque and decrepit old soul, seemed glad to have us as his guests even if we did use his cooking utensils as aquariums and fill his rice bowls with snakes. We learned at the time of our departure, when he followed us ten miles to ask for a larger gratuity, that his feebleness was more apparent than real. However, he did everything in his power to make us comfortable, even to repairing the bamboo water system that consisted of a trough supported so as to conduct water from a spring stream right into the temple kitchen. One day a worshipper left an enormous red candle to be burned before the largest image, and this provided light abundantly.

A few days later, I was on my knees investigating a dark cavity formed in the stream by several bowlders, when I noticed a tiny object, black

save for sparse mottlings of gold. It was resting on a stone in the bottom of the shallow water. After I had laboriously drained the pool, the creature was finally coaxed into a small bottle. It turned out to be a tadpole, *Staurois ricketti*, with its abdomen strongly suggestive of the bottom of a certain type of handy bed-room lamp made to adhere by a soft-rubber sucking disc to any polished surface. This tadpole's belly was little more than a perfect miniature sucker (see sucking-disc figures page 470). It is thus enabled to stick to the rocks and resist the pull of the swiftest current. But alas! in the bottle it had a miserable time trying to apply its cup-shaped sucker to the concave surface of the glass. In a short time it was dead from exhaustion. At first there was no way of telling just what sort of a frog this tadpole would have turned into, but careful and prolonged observation finally cleared up the question. The parent frog proved to be no less well adapted to a life in the swiftest cascades than its larva, for it was not only colored and mottled like the bed-rock of the streams in which it lived, but was provided as well with large adherent discs on the ends of its fully webbed fingers and toes. Its body and head were flat, offering little resistance to the rushing water. It could insert itself in the narrowest crevice with ease. One hot day, with perspiration streaming from every pore, I gazed longingly at several of these frogs enjoying the spray of a foaming waterfall while reposing in a dark cavity of the bed rock. At the first alarm they dived into the boiling current, swam through it, and landed in safety on the opposite side. How even their powerful legs and webbed feet can carry them through such a

Looking across Kuatun Valley. There is a delicate beauty in the high groves of bamboo that the camera fails to reproduce

A close look will disclose a man standing among these giant bamboos and give an idea of their great girth and height

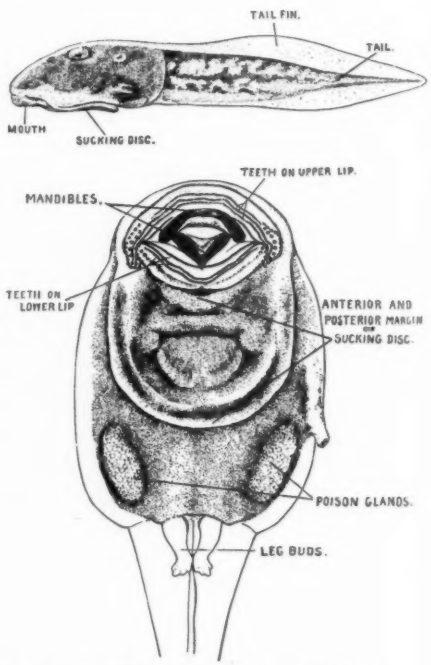


From the high, cool "lab" I looked out across a wide valley to a range of forested, grass-capped mountains. This porch is thirty feet above the very steep mountain-side below

current is a problem still to be solved.

Later in the season when these same gold-mottled, black tadpoles had become numerous in the streams, I was sitting beside a pool watching them slide about over the rocks. It was hard to see how they moved, as they are legless, but it was evident that they were either feeding on the microscopic growth and slime on the face of the rocks or simply sporting about in the clear water. I was beginning to think what a charmed life they were leading there in that peaceful, cool water, when I noticed a salamander gradually appear, sneaking out from under a rock. Though only eight inches long, it was, compared to the tiny tadpoles, a veritable monster. Slowly it advanced toward the nearest polliwog which fed on, unconscious of approaching danger. In one gulp the salamander most unceremoniously swallowed the innocent tad and deliberately directed its course toward the next.

It was in August that the frog with the mournful ending to its whistle became evident. At first its note was heard only here and there in the forest, but, after a few nights, the frequency had greatly increased. I went out with a bamboo torch to investigate and found the small creatures climbing around among the dwarf bamboos growing along the stream. Only the males were calling. At each sound a little pouch of translucent skin projected from either side of the caller's throat. Even my approach with the light did not frighten them so badly but that they would, after a short pause, begin to call again right before me. They were not to be distracted from this major business of singing their best love songs by the approach of a mere mortal. Strangely



Above.—Side view of *Staurois ricketti*.
Below.—Ventral view of same showing the sucker which enables it to stick to smooth, wet rocks, and resist the pull of the strongest currents. With the rasplike "teeth" it scrapes food from the surface of rocks

Dozens of new species of birds, mammals, reptiles, etc. have been described from Kuatun Mountain. The cross shows where our camp was located

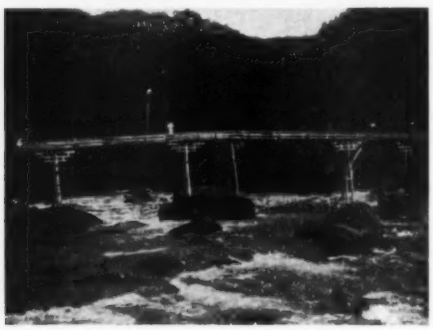
enough, previous frequent hunts in this same place had failed to reveal a single one, but here they were at last and in great numbers. By the third night the valley fairly rang with their incessant calling. Obviously they were gathering along the banks of the stream for their mating season; they had come to deposit their eggs in the swift stream. At this point observation was interrupted for two days; and on the third night, when I went out to continue work on them, not a whistle could I hear, nor could I find a trace of the myriads that had, only two nights before, filled the valley with their notes. They had disappeared more mysteriously and suddenly than they had come. Where had they gone? Up to the time of their breeding not a single one had been seen by us or brought in by the country people, and afterward quite as diligent searching failed to reveal one. The stream undoubtedly contained countless thousands of eggs but they were even more securely hidden than their depositors.

The old temple keeper proved himself to be something of a naturalist even though we could not accept all his theories and explanations. A small deer was brought in one day and he explained to us how that special variety sometimes gave birth at one time to no less than three different animals,—serow, goral, and muntjac. This belief might be styled the mutation theory par excellence. How rapid would the progress of evolution be if this were true! On another occasion he ran in to tell of an encounter he had just had with a tiger. The beast, evidently not a man-eater and more probably a leopard, upon seeing him wave his hands and hearing him shout, had sneaked off into the jungle and spared our naturalist to tell the tale.

It was on the day of our arrival that he had established his reputation as a true naturalist among us. Balls of

My headquarters for four months, thanks to the hospitality of its owners. The windows of the "lab" may be seen just under the eaves on the extreme left

"Salamander Mountain" seen across the roof of one of my temporary "labs." Note weights that keep the bark roof from being blown away



The trusses of this bridge are built upon a plan which is universal in Chinese architecture. Highly specialized cascade frogs abound in the stream beneath

Rare high-altitude frogs bred in this terraced rice field just back of our headquarters. The primitive yoke and plough shown is in common use in Fukien

white were hanging from a bush over the temple spring. They looked like Christmas decorations but close examination showed them to be composed of a light, frothy substance of the consistency of well-beaten white of egg, the froth containing in its turn hundreds of tiny white spheres. Each ball was pear-shaped and as large as two fists. Our naturalist confidently proclaimed them to be frog spawn, and before long, thanks to the incessant rain, we had ample opportunity to test the truthfulness of his contention.

One day at dusk a giant tree frog, one of our first specimens, began to call from a bucket in which we had confined it. Soon it was answered from the depths of the rain-soaked bamboo forest. More calls and more answers followed until the drenched mountain-side seemed to be taking on a new form of life. The answers not only increased in number but in volume as well, so we knew that our captive frog was starting a general gathering. We peeped out from the concealment of the temple doors and waited silently for many minutes. As the darkness fell our eyes became accustomed to the fading light and now and then we could just make out forms approaching by great leaps from every direction. These giants of the

The giant green tree frog (*Polypedates dennysi*) of Fukien lays its eggs in a rubbery, sticky mass of froth which it hangs from bushes over water. Such masses are shown just above the central line of this picture

frog world can advance several yards at a bound and now they were obviously gathering around the spring. It was a rare concert that we were hearing. Soon we cautiously stepped from the temple and slowly approached the small tree growing over the bush. Flashes from our light revealed a mass of frogs climbing over one another while clinging to a branch of the bush already bent down low over the spring by their weight. This plainly enough was their spring mating rendezvous, but there was one question that puzzled us: how could one frog lay such a large mass of frothy material as our informant maintained they did? Careful use of the flashlight there in the pouring rain,— how these slimy creatures revelled in the abundance of this element that made us complain so violently— answered the question, for it was seen that the female, while laying the eggs and clinging to the leaves with her forelimbs, used her hind feet to beat into a froth the egg-containing mucus as it came from her body. On the following morning the additional decorations hanging from this bush improved its appearance considerably.

We carefully studied the development of the eggs and also put numbers of them from one batch into fixing solution at regular intervals. At the end of the first week the tiny eggs had changed in form and assumed the form of polliwogs. The froth gradually liquefied and allowed the immature larvæ to wriggle their way downward until they finally dropped into the spring below.

THE SPIRIT OF THE TROPICS

The sudden squall with fickle winds and drenching rain has passed, the beach and the forest are quiet; soon the rushing muddy water in the foreground will have been lost in the sea; then in its place will be a quiet brook, and the coming night will find all serene and clear

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Light and Darkness in a Tropical Forest[1]

By H. C. RAVEN

Associate Curator, Comparative and Human Anatomy, American Museum

THE forest of Borneo suddenly resounds to a series of clear, shrill notes, "wat-wat-wat-wat." The watwats (the Malay name for gibbons) are calling, for they have detected the approaching dawn, and when the light spreads across the sky, they begin feeding on fruit and buds as they leap and squat and walk like man in the billowy tops of the largest trees. Meanwhile another high-pitched voice can be heard, certainly for more than a mile, calling "a-r-u-w-a-y"—"a-r-u-w-a-y." This is the aruway as the Malays call the argus pheasant. No one can see as yet his marvellous wings with their thousand eyes but, like his barnyard cousins, he heralds the coming of the dawn and then starts to seek his food on the damp leaves of the forest floor.

As if aroused by these restless ones, gaudy colored fruit pigeons, doves, and raucous-voiced hornbills take to the air. A variety of sounds, mostly the voices of birds, follows closely the spread of light from the eastern sky. Monkeys sway the otherwise motionless leaves as they follow one another, leaping from tree to tree. Giant squirrels three feet long calling "pert–pert–pert" with a whistling tone might easily be mistaken for birds, and pigmy squirrels with bodies not as large as my thumb creep like tiny parasites upon the liana-girdled boles of forest giants. Too numerous to mention are the myriads of peeping, whistling, booming, buzzing animals that are to be heard during the two hours following sunrise, and, besides, there are those quiet ones, such as the great white butterflies which float so silently beneath the leafy canopy, seeming to flutter only when struck by an occasional sunbeam.

The heat of the sun soon has its effect upon the life of the jungle, the animals become more quiet. They appear to have expended the surplus energy gained through a night of rest. For a time the forest, except for the buzzing of a few insects, is limp and still; then as the sun climbs higher, air drifts in from the coast. Frequently the breeze is hardly perceptible at first, for it has scarce force enough to warp long strands of spiders' webs hanging from the forest roof. It gradually increases, causing leaves to swing back and forth and the rattans to shimmer in the sunlight.

Through the later morning hours, midday, and early afternoon, when the sea breezes are gently drifting through the forest and the rays of the sun suck moisture from the great green sponge, the animals remain quiet except for sudden shrieks following the crash and boom of some great tree that for no apparent reason topples over.

When the sun begins to sink, the birds and other day-loving animals of the jungle again become active, as if they realized there would be but a short time in which to search for food before dark, although their afternoon activities are not quite so pronounced as those of the morning.

Sunset finds beautiful pittas whistling softly from the glens of deepest shadow, nutmeg pigeons with bulging

[1]The observations and photographs contained in this article were made during six years spent by Mr. Raven collecting in the East Indies for the United States National Museum.

crops leaving fruit trees to seek roosting places with others of their kind, and huge black and white hornbills flapping and soaring on humming[1] wings back

The watwat (gibbon) of Borneo is found in most localities where the virgin forest is undisturbed, and its clear shrill notes resound with freshness and vigor during the early morning hours and at dusk. The young watwat, like the young of the other anthropoid apes, makes a quiet, lovable, and intelligent pet

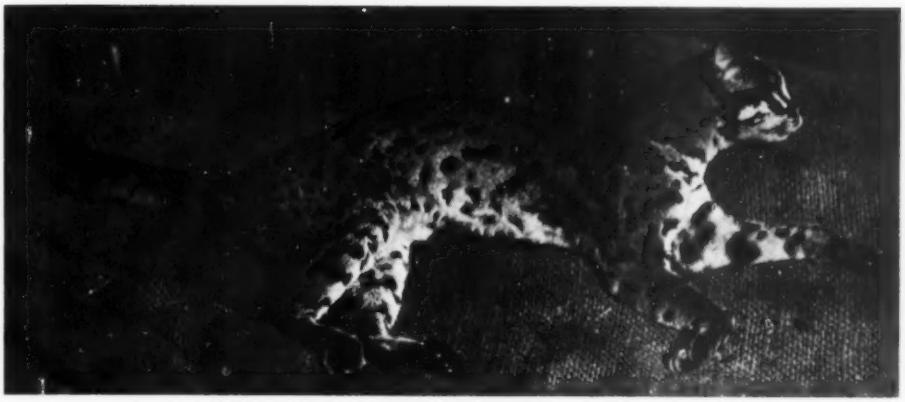
to the trees of their choice. Monkeys of many kinds in groups are gathering along the river banks to spend the night in the tops of trees overhanging the water. The calls of the aruway and the watwat compete with the almost deafening hum of countless cicadas.

Twenty minutes after sunset the light of day has gone, and the stars give barely light enough to detect the shadowy forms of huge fruit-bats, whose wing spread measures five feet or more, as they fly across the river level with the tops of the trees, or the smaller insectivorous bats that dip and dodge within a few feet of the water. The buzzing and humming of insects sounds like the beating of the surf on a distant shore. Above the noise of the insects may be heard the plaintive notes of the night hawk and the lonely call of a little owl. Occasionally the whirr of the wings of "Rajah-wali," that rare nocturnal hawk which catches bats on the wing, may be heard over the river as it plunges downward in pursuit of its prey.

It was perhaps two hours after dark that we heard a shrill "pow," the sound made by the sambur deer when alarmed. A few minutes later, equipped for jacking, Tambielawang and I stepped from the prahu to the canoe and then ashore. We walked silently along the beach toward the mangroves, keeping close up under the trees for the tide was high. I continually played the light about trying to see what there was. We were quite close to the scattered mangroves when I saw the reflection from two pairs of deer's eyes, which were easily recognized by their pale yellow color, like the flame of an oil lamp.

The reflection of the eyes of nearly all nocturnal animals can easily be seen with the light, and the different kinds show considerable variation. The eyes of insects, such as moths and butterflies, reflect a pink or reddish light, as do those of spiders, crawfishes, and fishes. Besides deer, the muntjacs and little mouse-deer (*Tragulus*) also reflect an even yellow light. The wild pigs reflect a pinkish light that is rather weak and always looks small. The banteng, water-buffalo, and many

[1]The vibrations of the wing feathers make a peculiar noise when the bird is in flight, both when soaring and when flapping the wings.



A small wild cat of Borneo, *Felis bengalensis*, with colors like those of the Bengal tiger but a color pattern peculiar to itself, is about the size of a house cat but of slightly different proportions

kinds of antelopes give a bright reflection, very pale yellowish or greenish in color, sometimes almost white.

Both deer were in water a foot or more deep. Keeping the light directed at them, I walked close to the mangroves where the sandy beach ended. We saw tracks in the sand where the samburs, both does, had come out of the forest. They looked toward the light for a few moments and then turned and walked along through the salt water, lowering their heads occasionally as though they were drinking. On several occasions I found sambur deer either in salt water or walking along the beaches near it, and I was interested to see if they drank the sea water. In attempting to follow these deer I accidentally made a noise when pulling my foot out of the mud; that frightened them, and they bounded away in the darkness.

We tried to get between and over the arched mangrove roots and through the mud, but this was slow, so we went inland through the forest, hoping to find more sandy beach beyond the mangroves, along which it would be easy to walk. When we reached the forest, we found lots of rattans and other vegetation blocking our way. For a few yards I pushed my way along, under vines and over logs, as I

One of the commonest poisonous snakes of Borneo and Celebes is the green pit viper (*Trimeresurus*). It is a handsome animal with the general form of a rattlesnake, bright green in color intermixed with a pattern of chalky-white and yellow, and with a brown tail

THE APPROACHING NIGHT

In the East Indies it is characteristic of the monkeys to spend the nights perched in the upper branches of trees overhanging the river banks. In the center of this picture is a group of three silky black langurs or "lutong," as they are called by the Malays

In the East Indies it is characteristic of the monkeys to spend the nights perched in the upper branches of trees overhanging the river banks. In the center of this picture is a group of three silky black langurs or "lutong," as they are called by the Malays

did not wish to risk making a noise by cutting with my machette. Finally, however, I stopped to get out the machette and pull a few thorns out of my arm. As I stood holding the light about waist high, Tambielawang suddenly exclaimed: "Djaga tuan! Ular tadung!" (Look out, Mister—a poisonous snake!) and, sure enough, right there, not more than two feet from me was a small green pit-viper, repeatedly and viciously striking at the light, its brown tail tightly coiled around the stem of a rattan. After watching the snake for a few moments I knocked it down on the ground, tied a little stick along its neck, so that it could not strike, and then Tambielawang carried it dangling from a piece of string.

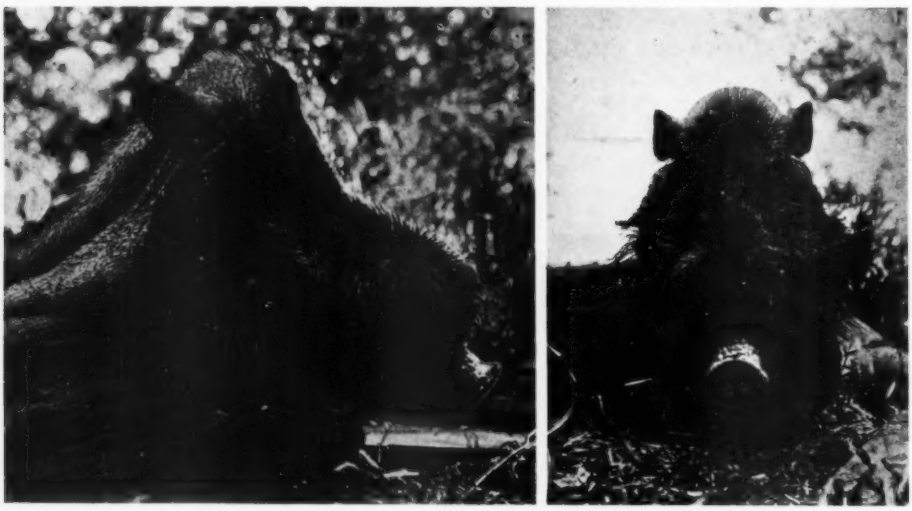
We did not find a way through to any more sandy beach, but on the bank of a little brook that emptied into the mangrove swamp we saw a beautiful cat, *Felis bengalensis*, about the size of a house cat. Its tail was slightly shorter than that of a house cat and its fur was the same color as that of the tiger from which it gets its name, orange-yellow and black above and whitish below and on the sides of the face. It sat on its haunches on the bank of the stream as we approached, looking just as quiet and peaceful as any domestic animal on a farm.

Nearly three hours after leaving the prahu we returned, deposited our specimens, and crossed to the beach on the other side of the river. When we neared the nipa palms I saw the reflection of an eye that glowed red like an ember and near it, but a little higher, a couple of eyes that looked pale pink. We walked very cautiously, frequently stopping and turning the light aside; for some animals, though apparently not alarmed by the light seem to dislike it, and if it is constantly directed at them, they turn their heads away and cannot be seen. When we were within fifteen or twenty yards, I could see the outlines of the animals. The eye with the red reflection was that of a crocodile just at the water's edge. Its lower jaw rested on the mud and its huge mouth was wide open, its body partly submerged in the water. Not more than fifteen feet from the crocodile's mouth were two wild pigs, one an old boar with a heavy bristly beard on his face and jowls; the other less hairy one was a female. Here was a thrilling scene. It was very evident that the crocodile was simply waiting for the pigs to come within reach, when it would grab one of them and try to pull it into the water, where it could be drowned. We stopped walking and watched as the pigs continued to root about in the mud beside the nipa palms. Occasionally, as one of them raised its snout from the mud, it gave a slight grunt or an audible sniff, but made no loud noises. They moved about, sometimes being thirty feet from the crocodile, and once or twice they seemed not more than eight or ten feet from the gaping jaws, and it looked as if they might back right into the waiting trap. We expected to see the crocodile spring forward but it remained absolutely motionless.

We had been watching for perhaps fifteen minutes when the pigs suddenly turned in our direction and sniffed. Then for a few seconds they were perfectly still, except for the end of the snout. Finally their tails and the bristles on the boar's back stood up and we knew they had scented us. With a prolonged "um-um-um-um" they trotted back into the forest. In my collection I had several boars so I used this opportunity to add this large

female. As we turned our attention again to the crocodile, it closed its mouth, turned, and started to swim away when disturbed by our voices. The noise of the gun, in this case, did not appear to have frightened it.

followed as quietly as possible, playing the light in all directions. Fortunately we were able to catch sight of the porcupine again and add it to our collection. It was a large specimen, some of its black and white quills being



The wild boars of Borneo are long-faced swine with warty growths on each side of the face. The warts are covered with long, very coarse bristles. The photographs show front and side views of the head of a large specimen

For some time we walked through the forest without hearing anything but the melancholy call of a little owl and the swish of leaves as a branch sprung upward, released by some fruit-bat starting its flight by simply falling into the air. We followed the trails made by deer and pigs, for I learned that this was the quietest way, and that many other animals besides deer and pigs used these runways. We halted upon hearing a slight noise, then continued more cautiously than ever. I caught the reflection of the eye of a mouse-deer which I presently secured. The report of the gun startled a big porcupine that was apparently feeding near by. The porcupine rustled its bristles and thumped on the ground with its hind foot as it ran away. We

about eighteen inches long and nearly as large around as an ordinary pencil. Tambielawang carried the mouse-deer and the porcupine, while I carried the light and the gun.

It was not more than two hours from the time we left the beach where I had killed the pig until we returned. As we approached the place where the carcass lay, we heard some animal running away. Upon reaching the carcass, I was surprised and disgusted to find that a pig, perhaps the boar we had seen earlier in the evening, had been there and had partly eaten the body of the female. Usually we found it safe to leave the carcass of an animal in the forest until early morning, but as a rule we covered it with boughs.

Night had more than half gone and

the tide was dead low when we stepped back on the prahu. I awakened the Malays and asked them what had become of the little green viper which we had left on the floor. No one knew. It was alive, and had squirmed free of the stick I had tied to its neck. We did not like the idea of its being loose somewhere in the boat, so we spent some time in taking up the floor boards, moving things about, and finally locating it, way forward, under a pile of firewood.

Just as I boarded the prahu I thought I saw the eye of a crocodile about fifty yards up stream from where we were anchored. Now standing on the cabin top, I took a good look and saw the tiny red glow. I told Tambielawang and Boega what I saw, and also told them we would go upstream after crocodiles in the canoe and that Tambielawang could harpoon while I held the light and Boega paddled the canoe.

The crocodile we had seen from the boat disappeared, so we continued quietly upstream. Boega squatted in the stern, Tambielawang sat close behind me in the bow; he paddled too. In many places the trees arched together high above the river. Everywhere the banks were sloping, slimy, muddy, blackish. The narrow dugout moved as silently as the river flowed, and the paddles were seldom lifted out of the water, so there was not often even the slight sound of dripping water. I saw the eyes of several crocodiles; most of them were small and all drew down backward under water when we approached within four or five feet of them. The river wound back and forth through flat terrain and just as we rounded a bend I saw the eye of a crocodile which was out of water.

When the eye is nearly on the level of the water, the reflection at a distance appears double or elliptical, for the reflection in the water is also seen, but when the eye is six inches above water, the reflection and the eye will appear to be a foot apart.

I directed the light at the eye while holding the lamp with my left hand and with my right pointed at the animal in an attempt to make Tambielawang see it. Meanwhile the canoe continued forward slowly and I could make out a small mud flat extending out from the slimy bank. I was within fifty feet of the eye when I realized that what I had taken to be a log on the mud flat was in reality the body of the crocodile, a much larger one than I had anticipated. Tambielawang stood up behind me with the harpoon and was arranging the line, but Boega who of course could not as yet see the animal, continued to send the canoe forward. It was but a few moments from the time I could see the body of the crocodile until we were uncomfortably close to it. Tambielawang did not throw the harpoon, so I whispered to Boega "Mundur" (back up). At the sound of my voice the big crocodile turned its head toward the water and raised one of its fore feet to take a

The mouse-deer (*Tragulus*) is a tiny deer-like animal without antlers, but the males are provided with sharp recurved canines. During my nightly wanderings in the great forests of Borneo, I frequently found them lying down, chewing their cud after having fed upon fallen fruit and the tender leaves growing close to the ground

Above.—My prahu, the "Bintang Kumala," built by Moros on one of the little islands off the east coast of Borneo, served to transport me and my Malay companions for hundreds of miles along the coast and up the rivers. At sea we used a large oblong sail on bamboo spars while on the rivers we rowed and poled.

Below.—The dugout canoe of the Malays and Dyaks of Borneo is a craft ideally suited to streams and rivers of that low lying forested country. It was a canoe of this type that we used in our frequent excursions along the rivers at night

step. By this time I had raised my shotgun to my shoulder and fired at the animal's neck and shoulder. Almost simultaneously with the discharge of the gun Tambielawang threw the harpoon. The crocodile thrashed about on the mud for a moment and then lay still.

When the animal began to thrash about, we quickly got the canoe out of

A human habitation where the the jungle has been replaced by fruit trees. Bread-fruit in the foreground, bananas to the left, dense mangoes behind two slender coconut palms, and to the right of them, two sugar palms

the way, close to the bank on the other side of the river. After it quieted down we paddled over and picked up the harpoon pole. The head of the harpoon was firmly fastened in the thick skin of the animal's neck. After waiting a few minutes more while the crocodile remained perfectly still, Tambielawang pulled on the harpoon line; the animal did not move, it was apparently dead. We grew bolder and ran the canoe up on the mud flat within a few feet of it. I was still squatting cross-legged in the bow of the canoe, holding the light in one hand and the gun in the other. We had a couple of two-tined fish spears with us, so I told Tambielawang to prod it, but though he prodded hard enough to shake the great body it showed no sign of life. I then told him to step out on the mud, take the animal by the tail and pull it around so that we could slide it into the water. He answered "Saia takut tuan, barangkali dia bulum mati" (I am afraid, Mister, perhaps it is not yet dead). I then took the fish spear and prodded it saying. "Tentu sudah mati" (Certainly, it's dead), but he simply repeated "Saia takut." With that I handed him the light and stepped off into the slimy black mud.

The mud came half way to my knees and I nearly lost my balance at each step, but about half a dozen steps brought me to the side of the animal. A few more steps and I could reach the tail. To steady myself I touched the animal's back with my hand—it was as if I had received an electric shock—it moved, its jaws sprang open and it flung its great head toward me and snapped the jaws shut just behind me. Its tail also curved round toward me. Then, for a moment that seemed an age, the light was turned away and I

was left in utter darkness. Tambielawang and Boega had shoved the canoe off and were already near the far bank. I called to them and told them to keep the light directed my way, and eventually I got them to come nearer.

The crocodile made just the one quick move and then lay still, but I expected to be grabbed at any moment. Some branches that almost reached the water at high tide hung out over the mud flat. By walking a few feet I managed to reach up and catch these branches and pull myself up the bank to safety. We all worked up stream a few yards beyond the mud, and there they passed my gun up to me. There was but one cartridge left, but with it I failed to kill the crocodile. It seemed to be paralyzed so that it could not go forward but thrashed about in a most terrifying way.

Tambielawang speared it with the fish spears but it only thrashed about, breaking the bamboo shafts, and becoming entirely tangled in the harpoon line. Finally we cut long saplings with which we succeeded in pushing the animal into the water, where we could tow it behind the canoe with the harpoon line. Twice while going down stream it thrashed for a few moments, then again acted as if it were dead.

When we reached the prahu, the boy on board had a rope ready with a noose. We guided the crocodile right into this noose and drew it tight about its neck. Then all hands took hold and we pulled our specimen out on the sandy beach.

The air was damp and cool, all the vegetation round about was laden with dew, and there was a slight mist as we stood on the little beach. The light of the lamp was growing dim, the oil was nearly finished. One of the Malays yawned; the rest of us yawned; then we all climbed back on the prahu and, just as I lay down on my rattan mat, we heard the watwats call—it was "dini-hari" (the dawn of day).

A view of the Segah River in the interior of Dutch Borneo. To reach this spot required paddling and poling the prahu for fourteen days beyond the last Malay hut

How the Cassowary (*Casuarius bennettii*) Goes A-fishing

By E. W. GUDGER
Bibliographer and Associate in Ichthyology, American Museum

WHEN one recalls that the cassowary is a huge bird belonging to the family Struthionidae—birds with rudimentary wings—of which the best known member is the ostrich, one instinctively recalls that the ostrich inhabits the desert regions of the Sudan, the Sahara, and the Kalahari. Hence the generalization is apt to be made that the cassowary also is a desert dweller. This is fairly true of the Australian cassowary which inhabits the Cape York section of the island-continent. However, the other members of the genus dwell in Papua or New Guinea, and the islands to the east of it, and in the easterly islands of the East Indies—the Moluccas. These islands all have a fairly heavy rainfall, and here in their large forests or in the grassy plains between them live the cassowaries, alone or in couples, but as a general rule not in flocks.

Now the most interesting things to be learned by the average person about any animal are its habits; how it gets its food, how it avoids being converted into food by other animals, and how it perpetuates its kind. And these things are particularly interesting about animals from far away countries, such as the bird under consideration, which we ordinarily know from books only or, at best, from mounted specimens in museums.

As to the food of the cassowary, it is to be feared that the knowledge of most persons, like that of the present writer before he began to collect notes on this bird, is confined to the famous rhyme (with which I have taken some liberties):

'Twas a bold bad cassowary,
On the plains of Timbuctoo,
Sinfully ate a missionary,
Body, boots, and hymn book too.

As a matter of fact, the cassowary, like the ostrich and the Struthiones generally, is omnivorous (but not to the extent indicated above). In the wild state it feeds chiefly on fruits and nuts, but, according to the authorities, it likewise greedily devours animal food and will feed on mice, lizards, frogs, fishes, crustaceans, insects, etc. Tame cassowaries have been known also to swallow bones, whetstones, corks, nails, fruit stones, and raw potatoes, all of which were passed through the digestive tract unchanged. In fact, the excrements of the wild birds are so copious and heterogeneous that they have often been mistaken for those of some large mammal. In captivity these birds are ordinarily fed on soaked bread, cooked potatoes, scraps of meat, fruit, etc.

But most of us are so obsessed with the idea that all struthious birds are dry (very dry) land dwellers that we find it hard to believe they would go into the water, much less get their food out of it. Yet Salvadori[1] tells us that cassowaries frequent parts close to streams and that they even enter the water to bathe. More specifically Ramsay[2] writes of the Australian cassowary, that:

[1]Salvadori, Tomasso, Monografia dell gen. *Casuarius*, Briss. *Memorie Reale Accademia Scienze Torino*, 1883, 2. ser. tomo 34, pp. 175 and 191.

[2]Ramsay, E. P., On the Habits of the Australian Cassowary, *Casuarius australis*. *Proceedings Zoölogical Society of London*, 1876, p. 121.

> At all times I have noticed that they are very fond of bathing. The semi-adult bird . . . was remarkable in this respect and might frequently be seen waiting at the pump in the yard until some one came for water, when he would sit quietly under a copious shower, stretching out his neck and ruffling up his feathers to allow the water to reach the skin.

George Bennett[3] kept as pets four specimens of the mooruk (*Casuarius bennettii*) from the island of New Britain. Of their habits and behavior he has given most interesting accounts which are well worth looking up *in extenso* by the interested reader. These mooruks came from a particular section in New Britain. Herein is reproduced Bennett's drawing of the island group of which he says.

The mooruk (*Casuarius bennettii*) of New Britain, Western Pacific. After Bennett

> The chart will show the position of the island [of New Britain] and the small figure of the bird marks the place from whence it was procured.

He was informed by the captain of the trading schooner from whom he got the birds that they had been sold to him by the natives, who declared that they are captured soon after they are hatched and are reared by hand. The words "mooruk" and "morroop" are the native names of Bennett's cassowary and are supposed to be a reproduction of the sounds made by the birds, but Bennett never heard his pets give utterance to such sounds, or any remotely approaching them.

In 1858 Bennett got two young specimens of *C. bennettii* from the sea captain referred to, who had had them on board his trading schooner for eight months. They were very tame and became very amusing if sometimes obstreperous pets. With regard to their habits leading to the matter under consideration, Bennett states that they were fond of ruffling out all their feathers and spreading their diminutive wings; that their skins were white and their feathers always clean and smooth. While they ordinarily sought shelter from rain, on hot days in December they liked to have buckets of water thrown on them and to roll about in pools of water. On occasion they would go out in a shower and evidently enjoyed it, but when they left the water they would shake their feathers as a dog does his fur, and would always keep their plumage clean and shining.

Furthermore, the cassowaries can and will swim, and swim well—a most surprising thing when one examines

[3]Bennett, George, Notes on the "Mooruk" (*Casuarius bennettii*). *Proceedings Zoölogical Society of London*, 1859. pp. 32–34.—Gatherings of a Naturalist in Australia. London, 1860. Chapter XI. The Mooruk or Cassowary of New Britain, South Pacific Ocean. pp. 243–264, colored plate, text-fig. on p. 248.

their feet, organs plainly intended for scratching and for running. Beccari[1] speaking apparently of the cassowary of Ceram (*C. galeatus*), of which he carried several specimens about with him on his journeys, says:

> Cassowaries like water very much, and, during the time mine were on board, they often dove of their own accord into the sea during the hot part of the day, but they did not go far from the schooner.

This must be taken to mean that they swam around the vessel. Ramsay (1876), writing of *C. australis*, says, "I found the cassowaries to be excellent swimmers," and he quotes an inspector of police in north Queensland that he had found one swimming across a river of considerable width.

But the reader is asking, "What evidence is there that the cassowary catches the fishes which it is alleged to eat?" My answer is to produce two witnesses and let them speak for themselves. The first is the well known traveler and collector, O. Beccari, who has already been quoted and who writes:

> Hunters have told me that the cassowary of Ceram [*C. galeatus*] often goes into the ocean and squats down in places where the water is not very deep, among corals where there are many small fishes, crustaceans, etc. When it returns to the shore, it shakes its feathers and all the small marine animals that have stuck to and among these then become its prey.

"But," says the reader, "this is merely hearsay evidence, and has no scientific value." True, but it is of corroboratory value when taken in connection with the next citation which is the first-hand observation

[1]Beccari, O., Lettera Ornitologica Intorno agli Uccelli Osservati Durante un Recente Viaggio alla Nuova Guinea. *Annali Museo Civico Storia Naturale*, Genova, 1875, vol. 7, pp. 718–719.

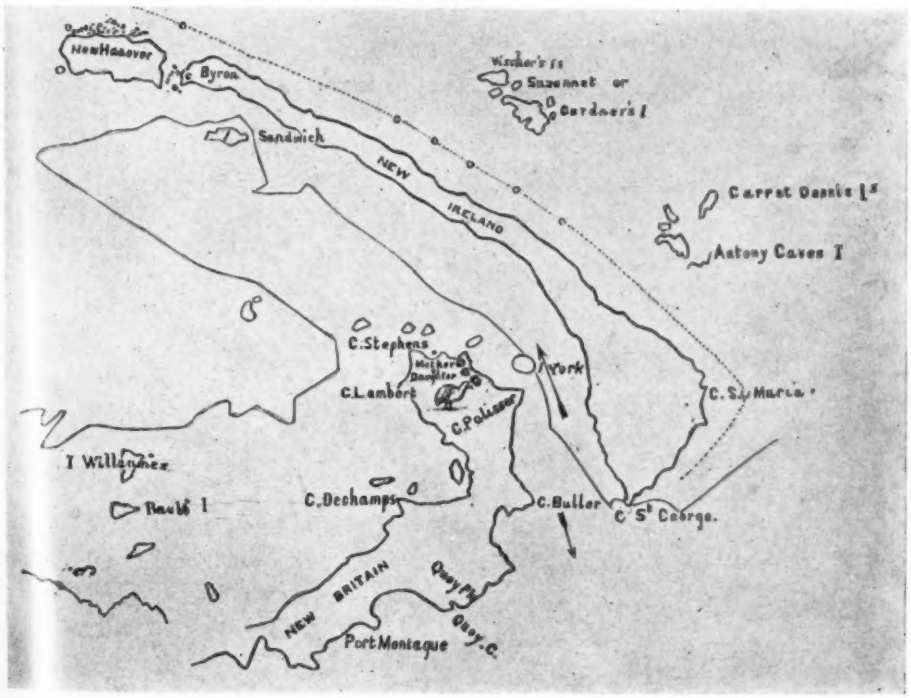


Chart of New Britain. The small sketch of the bird shows where it was taken. After Bennett

of a scientific man, Wilfred Powell.[1] He had been told that the morroop was very fond of fish but no statement was made as to how the bird caught the fishes. However, one day he saw with his own eyes the whole performance, and here is his description of it.

I was one day some little distance up a river in New Britain, sitting in my little dingey fishing (the boat and myself being partly hidden by bushes); I saw a Morroop (Cassowary) come down to the water's edge and stand for some minutes apparently watching the water carefully; it then stepped into the river where the water was about three feet deep, and, partially squatting down, spread its wings out, submerging them, the feathers being spread and ruffled. The bird remained perfectly motionless; I also noticed that the eyes were closed as if asleep. It remained in this position for fully a quarter of an hour, when suddenly closing its wings and straightening its feathers, it stepped out on to the bank, where, shaking itself several times a number of small fishes fell from under its wings and from amidst the feathers, which were immediately picked up and swallowed. The fishes had evidently mistaken the feathers for a description of weed that grows in the water along the banks of the rivers in this island, and very much resembles the feathers of the Cassowary, and in which the smaller fish hide to avoid the larger ones that prey on them.

[1]Powell, Wilfred. Field Notes on the Morroop (*Casuarius bennettii*) of New Britain. *Proceedings Zoölogical Society of London*, 1880, pp. 493–495.—Wanderings in a Wild Country, or Three Years amongst the Cannibals of New Britain. London, 1883. Appendix, pp. 270–274.

The same account is found *verbatim* in Mr. Powell's book, *Wanderings in a Wild Country*. Mr. Powell was a Fellow of the Royal Geographical Society; he spent three years among the people of whom he writes, and his account of the morroop was published by the Zoological Society of London. I have read his book and find that it tallies in general data about the animals with what one finds in other works dealing with the islands of this region. The explanation as to why the fishes take refuge under the wings and amid the feathers of the cassowary is one which will appeal to all who know anything of the habits of fishes. These habits of hiding are so well known to the native inhabitants of various parts of the western Pacific, that they suspend in the water bunches of grass and leaves and then presently surround these with their nets, confident of making catches of the fishes which will seek shelter under them. As for myself, I see no reason to doubt Powell's account and I give it my full credence.

Drawn by W. E. Belanske under the supervision of Doctor Gudger, to show their conception of how the cassowary does his fishing

Merin's boy playing his fiddle at Tsagan Nor. Photograph reproduced by courtesy of the Central Asiatic Expedition

Two Mongolian Folk Songs[1]

By L. B. ROBERTS
Topographer of the Central Asiatic Expeditions

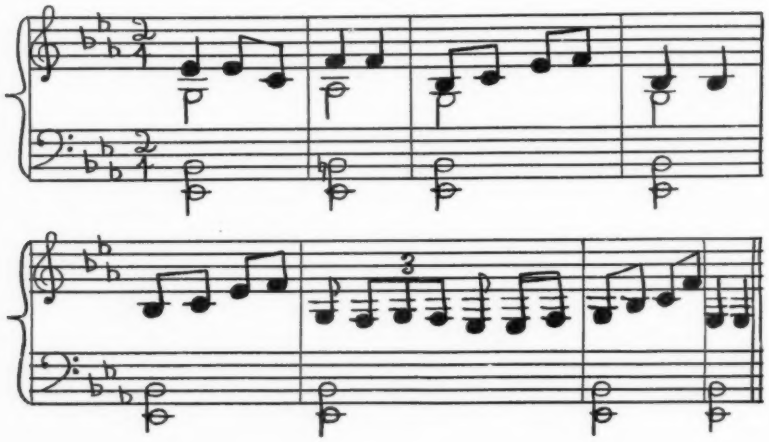
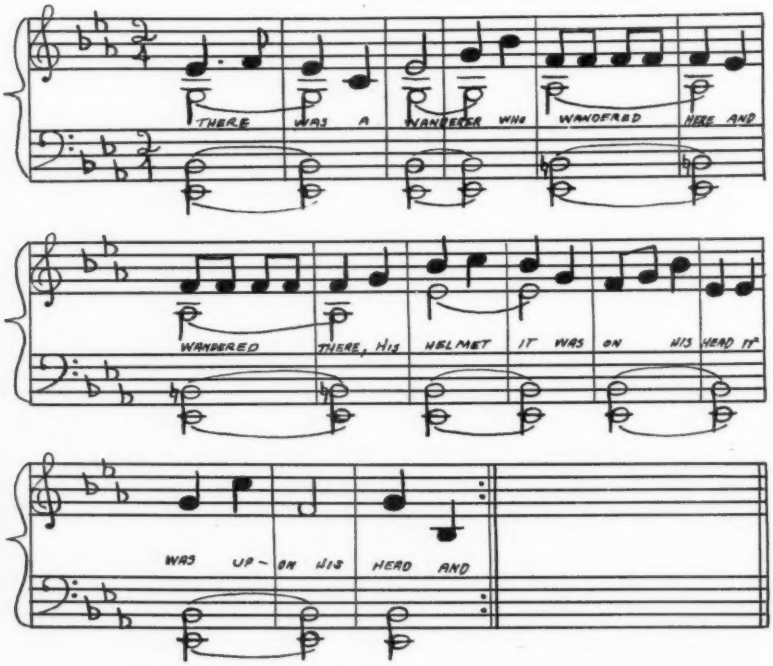
THE Mongols were singing again tonight, in a minor cadence, with constant repetition.

I asked Buckshot and Dalai Badajapoff to go with me to Merin's tent; for I felt that with these two as interpreters, I could arrive at a reasonable understanding of their songs. I recognized the tunes as the ones they have sung ever since they joined us at Shabarakh Usu. Sometimes they sing these for two or three hours steadily.

Merin's tent is larger than the average, about fourteen feet long, blue in color with good-luck symbols in clever scrolls worked into the sides with white cloth. Ten Mongol camel drivers call it home, as they eat and sleep there; they use no cots but spread their layer of felt on the ground, put their sheepskins at the edge of the tent for a wind break, and manage very well.

Merin, as chief of the caravan, had his usual seat of honor in the group, on

[1]An extract from the note book kept by Mr. Roberts while in the Gobi Desert during 1925.

WAR SONG

LOVE SONG

There was a wanderer,
Who wandered here and wandered there;
His helmet it was on his head,
It was upon his head. And

From the mountain he could see,
His native land, his native land,
And as he left his native land,
Each cheek it had a tear. And

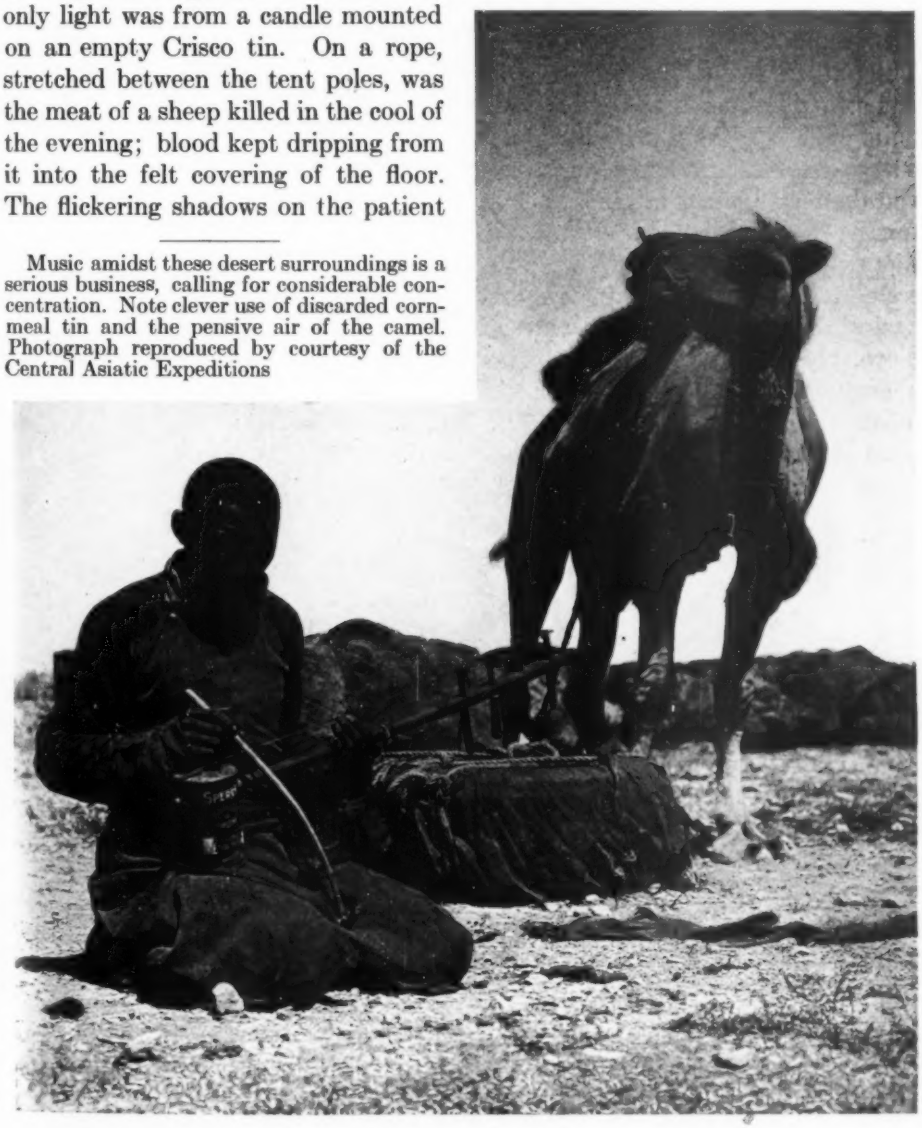
As he looked from the mountain,
He saw a foreign land, saw a foreign land
And as he went into this land,
His sleeves were wet with tears. But

Always on his wanderings,
As he wandered here and wandered there,
He thought of wife and native land,
Of wife and native land.

a prayer rug which came from Tibet. With rare and quiet courtesy he asked me to sit in his place. The food, a terrible mixture, was being boiled in a big, open kettle at the entrance. The smoke, acrid and hard on the eyes, from the argol fire, filled the tent with weaving eddies; the interior was black and plenty dirty.

The wind was blowing hard outside, blowing sand against the tent; our only light was from a candle mounted on an empty Crisco tin. On a rope, stretched between the tent poles, was the meat of a sheep killed in the cool of the evening; blood kept dripping from it into the felt covering of the floor. The flickering shadows on the patient faces of the Mongols gave me a decided impression of primitive strength which seemed to harmonize with our surroundings. It is remarkable how these men resemble our Indians at home; I've seen some in Oklahoma and Arizona who might be blood brothers to them.

Merin is getting along in years; he must be at least sixty, I'm told, and his



Music amidst these desert surroundings is a serious business, calling for considerable concentration. Note clever use of discarded cornmeal tin and the pensive air of the camel. Photograph reproduced by courtesy of the Central Asiatic Expeditions

face is lined and seamed from dealing, for so long a time, with weather and with men. As a rule he is very sober-minded, but he entered into the spirit of the occasion, and he, too, sang for me. All of these men have passed through bloody times.

Two of them played the instruments —one had a fiddle, the other a sort of guitar. They were rare instruments, and it seemed to me that it was a most remarkable thing that any tune whatever could be obtained from them. The guitar was held together with wire and string and yet it stood the strain quite well. The belly of the fiddle was a large corn meal tin; it had four strings and the method of producing different tones was peculiar, for the bow was slipped between the strings and the scale run by pressing the bow first against one string by a downward movement for one note and by an outward pressure against one of the other strings for the next note. The faces of the players showed absolutely no emotion—they played the monotonous strains over and over without a change of facial expression.

The complete stock of songs amounted to two distinct melodies— Dalai said at once that they were very, very old; were sung by the men who followed Ghengiz Khan. One appeared to be a war song and my efforts to get any translation met with complete failure. As I finally understood the matter, a foreigner broke into the yurt of a peaceable Mongol, stole his wife and sheep, so all good men should unite in driving out the foreign people. The melody, however, I was able to get on paper in a reasonably correct manner. The words evidently are made up and sung as they come to mind, the same methods used by the bards of ancient time.

I fared a bit better with the other melody, a love song; they sang it over and over again until I really had it; simple melodies both of them, but unforgettable.

Professor Arrhenius in his garden. Photograph by Clyde Fisher, June 21, 1924

Svante Arrhenius
1859-1927

By CLYDE FISHER

Curator of Visual Instruction and In Charge of Astronomy, American Museum

WITH the passing of Prof. Svante Arrhenius on October 2, 1927, the world lost one of its greatest scientists. Although only sixty-eight years old at the time of his death he had accomplished epoch-making results in at least four fields of science.

His first interest in research was in physical chemistry, and in his dissertation for the Doctorate in Philosophy at the University of Upsala, he set forth the theory of Electrolytic Dissociation. It is not often that theses for the Doctorate are ever heard of again after being accepted, but here was one by a young Swedish student that contained an absolutely new idea which was destined to become the basis of possibly the most ingenious and productive theory in the field of chemistry. Presented in 1883, the Electrolytic Dissociation Theory is, after nearly half a century, still the basis of modern chemistry.

This contribution to science would alone have been sufficient to have placed Arrhenius among the world's greatest investigators, but he did not stop here.

After a thoroughgoing and fruitful study of

liquid solutions, he began to extend his dissociation idea also to gases. This at once opened up an entirely new and vast field, namely that of cosmic physics. He investigated the influence of the moon upon lightning, the northern lights, the effect of atmospheric carbonic acid gas upon the temperature of the earth's surface, etc. As the culmination of these researches he wrote his *Textbook of Cosmic Physics*.

Since there are no hard and fast lines in nature, and since every science is related to every other science, Arrhenius was soon carrying on research in astronomy. One of the interesting theories he advanced in the field of cosmic physics was that rays of light exert a very feeble pressure, and on the basis of this assumption he was able to explain many otherwise incomprehensible phenomena. The great astronomer, Schwarzschild, further developed Arrhenius' theory on the nature of comets and their tails.

Like Huxley in the biological field, Arrhenius has presented his views of the universe in popular form, and these contributions have endeared him to the lay readers. Among these books we have *Worlds in the Making*, *The Destinies of the Stars*, *Life of the Universe as Conceived by Man, and Earth and the Universe*, most of which have been translated into nearly all languages.

And Arrhenius' activity did not end here, for this most versatile man did great service in the field of medicine. His researches here were chiefly in the study of the chemistry of toxins and anti-toxins, and he brought together his results in a fundamental work entitled *Immunochemie* (*The Chemistry of Immunity*).

Arrhenius received his Ph.D. degree in 1884 from the University of Upsala. Later he received many honorary degrees from the leading universities of the world. Among his many degrees were four different kinds of doctorates, namely Ph.D., M.D., D.Sc., and LL.D. He won the Nobel Prize in Chemistry in 1903, and since 1905 had been director of the Physico-Chemical Department of the Nobel Institute at Stockholm. He won the Davy Medal in 1902 and the Faraday Medal in 1914. Heidelberg and Groningen made him a Doctor of Medicine, *honoris causa;* Oxford and Cambridge bestowed the honorary degree of Doctor of Science. He was also an honorary Doctor of Philosophy at Leipzig and a Doctor of Laws at Birmingham. Many scientific societies throughout the world paid him the tribute of honorary membership. Among his books there should be mentioned, besides those cited above, *Electro-chemistry* and *Chemistry in Modern Life*.

Arrhenius was twice married, in 1894 to Sophia Rudbeck; in 1905 to Maria Johanson. He left two sons and two daughters.

During the latter years of his life, Arrhenius was president of the Sverige-Amerika Stiftelsen, and helped select the students who came to America on an exchange basis organized and conducted by the American-Scandinavian Foundation.

Now it must not be supposed that the head of this man was turned by the many honors that were bestowed upon him for his various achievements, for it was not. While a student at Johns Hopkins under the regime of Remsen, the great American chemist, it was my good fortune to hear Arrhenius discuss his researches on one of his lecture trips to this country. Then in 1924 and again in 1925 it was my privilege to visit Arrhenius in his home at the Nobel Institute in Stockholm. I found him a modest, approachable, lovable man. To be a great human man is one thing; to be one of the world's greatest scientists is another; but to be both in one, as Arrhenius undoubtedly was, calls forth our admiration and our affection.

NOTES

APPOINTMENTS

PROF. HENRY FAIRFIELD OSBORN was appointed Curator-in-chief of the Division of Mineralogy, Geology, Geography, and Astronomy at the October meeting of the American Museum Executive Committee. At this meeting the following resolution was unanimously adopted by the Committee:

Resolved, That in accordance with the recommendation of the Director and the Ad Interim Committee, the Executive Committee hereby appoint Professor Henry Fairfield Osborn Curator-in Ch ef of the Division of Mineralogy, Geology, Geography, and Astronomy, and Curator-in-Chief of the Department of Geology and Palæontology for the year 1927, and desire to express to Professor Osborn their appreciation of his willingness to undertake this service for the Museum.

THE DIRECTORSHIP OF THE MUSEUM OF COMPARATIVE ZOÖLOGY.—Dr. Thomas Barbour, a distinguished naturalist, well known to all students of vertebrate zoölogy, has just been appointed to the directorship of the Museum of Comparative Zoology, Harvard University. He succeeds Mr. Samuel Henshaw, who has been director since 1912 of one of America's largest and most complete collections of zoölogical material. Doctor Barbour brings to this office a broad knowledge gained through many years of field work in the East and West Indies, in southern Asia, South America, and particularly in Central America. As one of the organizers and directors of the Barro-Colorado Zoölogical Station in Panama, as one of the leading spirits in the development of the Harvard Institute for Tropical Biology and Medicine, and as a very active curator at the Museum of Comparative Zoology, Doctor Barbour has done perhaps more than any other American biologist to open up the animal life of the American tropics to investigation and close study.

Doctor Barbour's recognized ability as an administrator is attested by the great number of offices he holds in scientific institutions and societies. He is a member of the faculties of Harvard University and of the Harvard School of Tropical Medicine, a member of the Library Counsel, and one of the curators of Harvard College Library. Although Doctor Barbour has published papers in many fields of vertebrate zoölogy, his chief interest centers in the distribution and systematics of reptiles and amphibians.

ASTRONOMY

THE AMATEUR ASTRONOMERS ASSOCIATION meets at 8:15 o'clock, every first and third Thursday evening at the American Museum.

THE PROGRAM COMMITTEE is arranging an inspiring course of lectures by prominent speakers for the indoor meetings. Dr. Harlow Shapley, director of the Harvard Observatory, has promised to address the Association on December 15 on "Current Astronomical Researches at the Harvard Observatory."

THREE TELESCOPES LOANED.—A fine spirit of coöperation is being shown by the members of the Amateur Astronomers Association in the loan of three equatorially mounted telescopes, one of which is a 6-inch Alvin Clark. These, together with the one now in use, will enable a larger number of persons to view the heavenly bodies at night from the lawns of the American Museum. As the membership in the society is rapidly increasing, the loan of telescopes is much appreciated.

ADVISORY COUNCIL.—The new astronomical society, the Amateur Astronomers Association, is fortunate in that the following persons have kindly agreed to serve on its advisory council:

Prof. Henry Fairfield Osborn, President, American Museum of Natural History.
Dr. Frederick Slocum, Director, Wesleyan University Observatory.
Dr. Caroline E. Furness, Prof. of Astronomy, Vassar College.
Dr. Anne S. Young, Director, Mount Holyoke Observatory.
Dr. S. A. Mitchell, Director, University of Virginia Observatory.
Dr. Asaph Hall, U. S. Naval Observatory.
Dr. Frank Schlesinger, Director, Yale University Observatory.
Dr. Henry Norris Russell, Director, Princeton University Observatory.
Dr. Harlow Shapley, Director, Harvard College Observatory.
Dr. Edwin B. Frost, Director, Yerkes Observatory.
Dr. Heber D. Curtis, Director, Alleghany Observatory, Univ. of Pittsburgh.
Dr. John A. Miller, Director, Swarthmore College Observatory.
Dr. C. H. Abbott, Smithsonian Institution.
Mr. Howard Russell Butler, N. A., formerly of Princeton University.
Mr. Worcester Reed Warner, of Warner & Swasey Co.
Mr. David Pickering, President of the American Association of Variable Star Observers.

BIRDS

THE RUWENZORI-KIVU EXPEDITION.—Dr. James P. Chapin and Mr. DeWitt L. Sage returned from their African trip on September 25. This expedition was made possible through the generosity of Mr. H. W. Sage, and a further contribution was added by Mr. Childs Frick. Eighteen months were spent between Mombasa and Cape Town, of which one year was devoted to work in the eastern Belgian Congo. Mr. Frank P. Mathews, their companion in the early part of the expedition, returned to this country in the autumn of 1926 to resume his studies at Harvard University.

After an investigation of the Ruwenzori Range and Semliki Valley, Doctor Chapin and Mr. Sage traveled southward through the mountains west of Lake Edward and stayed for three months in the country about the Kivu volcanoes. With the generous authorization of the Belgian Ministry of Colonies, they paid particular attention to the birds of the Parc National Albert, a wild-life sanctuary occupying one of the most beautiful spots in Africa and consecrated by the grave of Carl Akeley.

Mount Hood, Oregon. Photograph through the courtesy of the U. S. Forest Service

The homeward journey continued by way of lakes Kivu and Tanganyika, the Katanga district, and South Africa. The results of the expedition include about 2600 birds for the Museum's collections, several hundred small mammals, reptiles, amphibians, and fishes, as well as a series of photographs and several thousand feet of motion-picture film. The motion pictures are the special contribution of Mr. Sage.

BLUE GEESE.—For three consecutive years Mr. R. L. Lambert of the National Zoological Park in Washington has been experimenting with the hatching and rearing of young blue geese from eggs obtained from a captive pair in the National Zoo. He achieved such success in this hitherto unaccomplished feat that the Société Nationale d'Acclimatation awarded its silver medal to the National Zoological Park. The medal was accepted from the Society by Ambassador Herrick and transmitted through the State Department to Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution.

The society awarding the medal was founded in 1854 by Isidore Geoffroy Saint Hilaire to stimulate acclimatization of plants and animals to regions in which they are not native.

COMPARATIVE ANATOMY

THE DEPARTMENT OF COMPARATIVE ANATOMY is engaged in the production of a series of twenty-five exhibits for a general Introduction to the Study of Man, in conjunction with the department of anthropology. The manuscript and illustrations for a general guide to the comparative anatomy of the human face have been completed.

ASSOCIATE CURATOR RAVEN is spending the months of October and November at Johns Hopkins University in study with Professor Huber on human and comparative anatomy and anatomical technique.

CONSERVATION

MOUNT HOOD TO BE PRESERVED FROM COMMERICAL DEVELOPMENT.—Col. William B. Greeley, Chief Forester, U. S. Department of Agriculture, recently denied an application from a commercial company for permission to construct an incline cableway to the summit

of Mount Hood, with rest rooms at the top and midway stations. He declared that in his opinion material gains in tourist traffic would fail to compensate for the loss in the esthetic and sentimental value of a mountain peak having the grandeur of Mount Hood, were it subjected to commercial development.

THE RAINY LAKE WATERSHED.—One of the most beautiful of the few remaining wild regions in the United States lies along the northeastern boundary of Minnesota, which is largely formed by a series of lakes having their outlet in the Rainy River, a tributary of the Lake of the Woods, whose waters eventually discharge into Hudson Bay. The destruction of the beauty and natural condition of this region is now threatened by the plans of Mr. E. H. Backus, capitalist and paper manufacturer of Minneapolis, who is seeking authority to build a series of dams to change the water level throughout an area of about 1400 square miles of lake and forest country, killing the timber along the lake shores, irreparably disfiguring the scenery and leaving the water level under control of a private corporation, to draw it off as it pleases for power or for floating out pulp wood. The region is the annual resort of thousands of tourists and vacationists and many summer camps and cottages are situated on the shores of the lakes whose beauty will be seriously damaged. As these waters form the international boundary for at least a couple of hundred miles, the matter has been referred by governments of the United States and Canada to the International Joint Commission, the permanent commission of the two countries for dealing with boundary questions, which will probably consider it at a meeting to be held in Washington next April (1928). Protests from those interested in fighting these plans for the destruction and exploitation of the Rainy River region may be made through their Senators or Congressmen or addressed directly to the "International Joint Commission, Washington, D. C."

EDUCATION

NEW MOTION PICTURE CATALOGUE.—The value of motion picture films in helping children visualize many school subjects is recognized by educational authorities, but without close correlation between the film and the classroom topic under discussion, there is the danger that film showings may be considered more in the form of entertainment than a true educational aid. Desiring to help teachers in securing this correlation, the department of public education in the American Museum of Natural History has prepared a new form of catalogue for its films.

The first section of the catalogue contains a list of the films classified according to subject. Each film is accompanied by a short description of the topics covered. The second section contains elementary and high school divisions which list the films according to both grade and subject.

At present the Museum has about 500,000 feet of film in active circulation in the New York City public schools. The Museum lends these films free of charge to any public school in Greater New York having a standard motion picture machine and a licensed operator. Deliveries of the films to and from the schools are made by the Museum messengers.

JAPANESE EXHIBIT.—The Japanese Educational Exhibit which had been displayed in the Palace of Education and Social Economy at the Sesquicentennial Exposition in Philadelphia was presented by the Minister of Education of the Japanese Government to the International Institute, Teachers College, Columbia University. Through the instrumentality of Prof. Milton C. Del Manzo of that institution, the exhibit has been presented to the department of education of the American Museum of Natural History, and it has been temporarily installed on the third floor of the School Service Building.

FOSSIL VERTEBRATES

PROFESSOR OSBORN employed his six months' leave of absence from presidential duties, May 10 to November 14, granted by the Trustees, in completing six volumes which have been under way for many years. Of these, the monograph on the Titanotheres for the United States Geological Survey, which was begun before he succeeded Mr. Jesup as President of the Museum in the year 1908, is now passing from galley to page proof in the Government printing office, under the able direction of Bernard H. Lane, present editor of the Survey Publications.

This colossal work, by far the most extensive monograph ever published in the realm of vertebrate palæontology, gives for the first time the complete history of a single family of mammals from the time when the ancestors

were less than knee high to the culminative period of animal grandeur which entitled them to the name *titanotheres*, originally given by Dr. Joseph Leidy, signifying *titan* beasts. For many years, Dr. William K. Gregory labored in the preparaton of this monograph with Professor Osborn, and thereby won his spurs as a vertebrate palæontologist, entitling him to the distinction he now enjoys as professor of vertebrate palæontology in Columbia University.

The monograph covers every aspect of titanothere life during the enormously long geologic period of transformation from Lower Eocene to Lower Oligocene time, so the work is a text and reference book of geology, of comparative anatomy, of paleo-geography, and of biology as well. It is here for the first time that Professor Osborn discovered how species actually originate. This is the last volume but one in the great series of the palæontologic monographs projected by the famous Professor Marsh of Yale University more than sixty years ago. In appreciation of his life-long work on this volume, the Geological Survey has recently promoted Professor Osborn to the rank of Senior Geologist.

The second volume which has greatly advanced during the past six months is that on the evolution of the Proboscidea, also a work of colossal size on which Professor Osborn has been engaged more or less steadily since the year 1908, when President Jesup sent him on an expedition, accompanied by Mr. Walter Granger, to the Fayum Desert in Northern Egypt, the ancient home of the elephant and mastodon family. This expedition was very successful in securing splendid specimens of these Lilliputian ancestral proboscideans which furnished the starting point not only of the proboscidean order but of the present monograph. The subject fascinated Professor Osborn so completely that he gradually extended the sphere of his research to the elephants and mastodonts of the entire world excepting the continent of Australia which was never reached by these hardy and adventurous explorers.

Proboscidean history is second only to human history in its romantic and historic episodes. The elephant, like man, has penetrated to every part of the globe and adapted himself to every climate and every form of feeding from the forests of the dry and humid tropics to the frozen Arctic tundras of the North. Nearly five hundred specific forms of these remarkable animals have been described, and extremely numerous and often fantastic generic names have been assigned to them. One of the most difficult problems in the preparation of this colossal work has been the unraveling of these names with justice to their various authors because they reach back into the primordial period of palæontology before the naming system of Carl Linnæus was adopted. Some of the greatest palæontologists, like Cuvier, were the greatest sinners and violators of modern rules of nomenclature. Another difficulty has been to get hold of the rare and out-of-the-way literature of many different languages in which these early descriptions and figures occur. In this matter the Librarian of the Museum has greatly assisted the amanuensis and editor of the text of this volume, Miss Percy; while the printing office has already produced nearly five hundred pages of the estimated number of one thousand pages which will make up the entire volume.

Owing to the extreme rarity of some of the literature and inaccessibility of the original illustrations, every original figure is being reproduced by the half-tone or direct process and all the original descriptions of species or genera are being reproduced either in full or in abbreviated form. Preparation of this part of the volume has been rendered possible only through the munificent gifts of research funds to the Museum by President Jesup and Vice-President J. Pierpont Morgan. To the latter the volume will be dedicated.

In the next number of NATURAL HISTORY will appear an account of two other volumes by Professor Osborn, which have recently been completed, namely, *Creative Education in School, College, University and Museum* and *Man Rises to Parnassus*.

In this connection it is interesting to acknowledge the generosity and liberal-mindedness of the Trustees in permanently setting aside five rooms in the southeast corner of the fifth floor of the Museum as the Osborn Research Rooms, including the Library Room, the Tower Research Room, the editorial anteroom, and two smaller secretarial rooms. In this relatively secluded and quiet part of the Museum, it has been possible to push forward the technical preparation of these six volumes, but for the actual dictation and writing of the text, retreat to a quiet log house, known as 'Woodsome Lodge,' in the Highlands on the Hudson, was essential. In this mountain

log house has not only a large part of the text of the present volumes been prepared, but 'Woodsome Lodge' is memorable as well as a place where John Muir finished his delightful biographic volume, *Boyhood and Youth*, also his more mature volume on *The Yosemite*.

For the present and future encouragement of research by junior members of the American Museum Staff, the seventieth birthday gift of $5000 to Professor Osborn is most welcome and opportune. Not desiring to use it for himself, on November 14 he presented it to the Endowment Fund of the Museum to be invested as the Osborn Palæontologic Research Fund. The interest of this Fund, which will amount to about $300 annually, will be used in the form of special grants, to be awarded on the completion of certain pieces of palæontologic research, especially to the younger workers in the field of vertebrate palæontology.

MR. BARNUM BROWN conducted reconnaissance work in the Rocky Mountain region during August and September. He visited two of the Department's collecting parties in Nebraska and examined dinosaur prospects in Colorado, Utah, Wyoming and Montana. While in Montana Mr. Brown collected fossils in a coal mine in the Fort Union formation near Red Lodge and secured several small mammal jaws and teeth, some of which are new to science. They will be described shortly by Dr. G. G. Simpson. This interesting new vertebrate field was reported by Dr. J. C. F. Siegfriedt who has also secured a valuable collection. The Department anticipates working in this field the coming year.

Mr. Brown discovered one dinosaur skeleton in Montana and several localities sufficiently promising to warrant investigation by a collecting party, and it is probable that next season will see a renewal of the Department's work in the North American dinosaur fields which has been discontinued since the last season in Montana — 1916. Two new Eocene mammal fields were located in Wyoming.

While in Utah Mr. Brown received a telegram from Mr. J. D. Figgins, director of the Colorado Museum of Natural History, that another arrowpoint had been located in association with fossil bison remains near Folsom, New Mexico. He proceeded immediately to the quarry with Director Figgins and completed the excavation of the artifact which had been left *in situ*. This is one of several occurrences of this sort in Oklahoma, Texas, and New Mexico, which were described by Director Figgins and Mr. Harold Cook in the May–June number of NATURAL HISTORY. Mr. Brown has brought back from the Denver Museum the various stone weapons and implements so found and he is now engaged in making comparisons with materials in the Eastern archæological collections.

MR. ALBERT THOMSON returned to the Museum in October from Western Nebraska where he has been carrying on for the seventh season excavations in the Snake Creek Pliocene beds. He brought back a fair-sized collection which includes several choice horse and camel skulls and more fragmentary remains of new or rare forms; altogether a worthy addition to this interesting fauna.

MIOCENE MAMMALS FROM AINSWORTH, NEB.—The Department has received recently a portion of a collection of Miocene Mammals made at Ainsworth, Nebraska, the past summer by two youthful local collectors—Messrs. Skinner and Quinn. In coöperation with Director Figgins of the Colorado Museum the entire collection made by these boys was purchased. The Colorado Museum took as its portion a mountable skeleton of one of the long-jawed mastodonts. The balance of the material, which has come to the Museum, includes a skull and jaws of a somewhat smaller individual of the long-jawed mastodont, five skulls with much of the skeletons of the short-legged rhinoceros *Aphelops*, and some important horse, camel, and carnivore material.

MR. CARL SORENSON, of the departmental laboratory staff, represented the American Museum this summer on a joint expedition between the Colorado Museum and this institution. The party worked in various localities of late Tertiary deposit in Nebraska and finished the season at Ainsworth where they completed the excavation of the *Aphelops* skeleton and attended to the packing and shipping of the entire collection.

FIELD WORK, DIRECTLY UNDER THE SUPERVISION OF MR. FRICK, has been carried on at Barstow, California, with Mr. Rak directing; at Santa Fe, New Mexico, with Mr. C. Falkenbach directing, and at Keams Cañon, Arizona, with Mr. Blick in charge. Each of these parties was successful in its search for late Tertiary mammals, but the one outstanding

specimen of all this work is a complete and beautifully preserved skull of a gigantic camel from the Keams Cañon.

HISTORY OF THE EARTH

FIELD EXCURSION OF STATE GEOLOGISTS IN NORTHWESTERN ILLINOIS.—On the invitation of Dr. M. M. Leighton, state geologist of Illinois, representatives of fourteen state geological surveys, the Federal Survey, and a number of universities and other educational organizations, and the director of the Russian Geological Survey assembled at Urbana on October 19 to attend a four-day field excursion in northwestern Illinois. The states represented were: Alabama, Illinois, Indiana, Iowa, Kansas, Kentucky, Nebraska, New Jersey, North Carolina, Mississippi, Oklahoma, Tennessee, and Wisconsin. The American Museum of Natural History sent Dr. Chester A. Reeds.

On Farm Creek, near Peoria, Illinois, the party visited the type locality of Pleistocene deposits representing the Illinoian and Wisconsin glacial drifts, and the Sangamon and Peorian interglacial deposits. A similar section, with the addition of a gumbotil on top of the Sangamon beds, was examined on the west bank of East Bureau Creek. Coal bed No. 5, and Mazon Creek, the famous locality for fossil leaves and insects, the St. Peter's sandstone and numerous limestone beds affording invertebrate fossils of Palæozoic age, were also visited.—C. A. REEDS.

INSECTS

THE STATION FOR THE STUDY OF INSECTS, 1927.— This was the third season for the department of entomology's field station in the Harriman State Park near Tuxedo, N. Y., in charge of Curator Frank E. Lutz. As in previous years, a Nature Trail was maintained in addition to the entomological work. It was in immediate charge of Albert Redmond. who was one of the younger guests at the Station in 1925 and 1926. Owing to the establishment by the Museum of a large Nature Trail in the Bear Mountain section of the Palisades Interstate Park, the Station's Trail was conducted primarily for trying out new ideas and as a demonstration of a Trail suitable for summer camps and small local organizations.

The principal adult guests this season were Dr. F. W. Brown, a chemist who studied the problem of how insects find their food; Mr. F. M. Brown, a teacher working chiefly on the bacteria and enzymes of insects; and Mr. James Kendall, a graduate student of entomology. In addition, there were three "junior guests."

Doctor Lutz was, in turn, a guest at the Alfred L. Loomis Laboratory in Tuxedo Park from time to time. There he investigated the possibilities of various biophysical problems involving the use of an unusually well-equipped laboratory such as Mr. Loomis has. This coöperation between the Loomis Laboratory and the Station for the Study of Insects was very helpful. Although Doctor Lutz's time was too much interrupted to permit of carrying any one line of work to completion, interesting results were obtained, particularly in proving that many insects—perhaps the majority of them—can survive sudden and extreme fluctuations of barometric pressure, including even "ion-less" vacuum, a much more complete vacuum than is ordinarily considered to be "high." If air-pressure were the only factor to be considered, it would seem that insects might pass from one planet to another.

MUSEUM STUDY COLLECTIONS.—In addition to the pleasingly large number of students who come for irregular and short times to study the Museum's collections, Mr. Geo. B. McReynolds is devoting considerable time to the study of our scorpions, and Mr. Ezekiel Rivney is doing a part of his graduate work by a study of our beetles. Miss Carol Cady is taking training here in entomological drawing and several boys come at stated times to work under direction on insects.

CURATOR LUTZ made a short trip to Washington in order to study the National Museum's excellent collection of West Indian bees. This is in connection with the Museum's part in the New York Academy's survey of Porto Rico.

THE LIBRARY

MR. WILLIAM K. VANDERBILT has presented to the Museum a copy of his beautiful book *To Galápagos on the "Ara,"* 1926. The narrative is supplemented by valuable natural history data and is illustrated by thirty colored plates as well as by numerous pictures in black and white.

Other recent accessions of interest include: *Journal of the Society for the Preservation of the Fauna of the Empire,* 1904–1927.

The first series of this file is out of print and the Society had difficulty in assembling the entire run for presentation to our Library. The only other file of this publication noted in the United List of Serials is in Washington.

Jahresbericht der Commission zur Wissenschaftlichen Untersuchung der Deutschen Meere in Kiel, Volumes 1–21, 1873–1891.

This completes our file which is the only perfect one in New York City.

Bollettino Della Societa Sismologia Italiana, Volumes 1–26, 1815–1926.

Zeitschrift für Konstitutionslehre, Volumes 1–12, 1914–1926. (Forms Abteilung II of Zeitschrift für die Gesamte Anatomie).

LIFE AND THE UNIVERSE

J. H. JEANS, secretary of the Royal Society, and eminent mathematical-physicist, closes a recent discourse on the development of cosmical physics with the following paragraphs:

A general survey of the results obtained by cosmical physics has suggested that terrestrial laboratory physics is a mere tail-end of the general science of physics. The primary physical process of the universe is the conversion of matter into radiation, a process which did not come within our terrestrial purview at all until 1904. The primary matter of the universe consists of highly dissociated atoms, a state of matter which, again, was not contemplated before 1917. The primary radiation of the universe is not visible light, but short-wave radiation of a hardness which would have seemed incredible at the beginning of the present century. Indeed, our whole knowledge of the really fundamental physical conditions of the universe in which we live is a growth of the last quarter of a century.

The simple explanation of this situation is to be found in the fact that life, naturally enough, begins its exploration of Nature by studying the conditions which immediately surround it; the study of the general conditions of the universe as a whole is a far more difficult task which life on this planet is only now approaching. Now the physical conditions under which life is possible form only a tiny fraction of the range of physical conditions which prevail in the universe as a whole. The very concept of life implies duration in time; there can be no life where the atoms change their make-up millions of times a second and no pair of atoms can ever become joined together. It also implies a certain mobility in space, and these two implications restrict life to the small range of physical conditions in which the liquid state is possible. Our survey of the universe has shown how small this range is in comparison with the range of the whole universe. Primeval matter must go on transforming itself into radiation for millions of millions of years to produce an infinitesimal amount of the inert on which life can exist. Even then, this residue of ash must not be too hot or too cold, or life will be impossible. It is difficult to imagine life of any high order except on planets warmed by a sun, and even after a star has lived its life of millions of millions of years, the chance, so far as we can calculate it, is still about a hundred thousand to one against its being a sun surrounded by planets. In every respect —space, time, physical conditions—life is limited to an almost inconceivably small corner of the universe.

What, then, is life? Is it the final climax towards which the whole creation moves, for which the millions of millions of years of transformation of matter in uninhabited stars and nebulæ, and of waste radiation into desert space, have been only an incredibly extravagant preparation? Or is it a mere accidental and possibly quite unimportant by-product of natural processes, which have some other and more stupendous end in view? Or, to glance at a still more modest line of thought, is it of the nature of a disease which affects matter in its old age, when it has lost the high temperature and capacity for generating high-frequency radiation with which younger and more vigorous matter would at once destroy life? Or, throwing humility aside, is it the only reality, which creates, instead of being created by, the colossal masses of the stars and nebulæ and the almost inconceivably long vistas of astronomical time? There are too many ways even to enumerate of interpreting the conclusions we have reached; I do not, however, think there is any one way of evading them.

MAMMALS

THE WHITEHOUSE COLLECTION.—Recently a very fine collection of 105 mounted heads and horns was presented to the American Museum by Norman De R. Whitehouse.

The trophies are from animals shot by his father, the late J. Henry Whitehouse, and assembled at the Whitehouse residence at Irvington-on-the-Hudson, and include buffalo, bison, sheep, and many species of antelope, takin, deer, moose, tiger, bear, zebra, and other animals.

Colonel Whitehouse, distantly related to W. Whitehouse, the African explorer, was a keen sportsman and hunter of big game. These relics of the chase represent many successful trips into almost all parts of the world, Africa, India, Russia, Tibet, North America, and some of the lesser known big game fields.

Many of the heads are rare and unusually large specimens. An Indian buffalo, listed by Rowland Ward in 1922 is the second largest on record. Thirty-two of the largest specimens were donated by the Museum to the

National Collection of Heads and Horns, Bronx Park.

LEE GARNETT DAY RORAIMA EXPEDITION.—Word has been received from the Lee Garnett Day Roraima Expedition both by cable and letter. The party has had difficulty in reaching Roraima principally because of lack of porters. The work on this Brazilian frontier by General Rondon and the Brazilian Boundary Commission makes great demands upon the transport facilities, which are very limited at the best. Mr. Tate found it necessary to return from the back country to Sao Marcos in order to meet General Rondon and secure the benefit of his advice. At the same time a small shipment of specimens was sent to the Museum. The delay in reaching Roraima is not lost time because collections are being made en route, and contain much valuable material. A letter from Mr. Carter tells of his killing a jaguar which had carried off a colt from one of the ranches, and also of securing several specimens of the giant anteater.

The following cablegram was received just as Natural History went to press:—

"Base Roraima October 25. Most of forest destroyed by fire. Well supplied stores for work. Expect to stay two months. Everybody well.—Tate."

VERNAY-FAUNTHORPE EXPEDITION.—Mr. Arthur S. Vernay sails from New York on November 24 to join Col. J. C. Faunthorpe in Bombay. Mr. Vernay and Colonel Faunthorpe are planning to carry on their work of collecting representative and rare specimens of Indian mammals for the American Museum by securing the Sondaicus rhinoceros, which will complete the group of Asiatic rhinoceroses. The Sondaicus, which is a small, one-horned species, is almost extinct, and it is therefore imperative that museum specimens be obtained without delay. The penalty for shooting one of these animals is six months imprisonment, but through the kindness of Sir Harcourt Butler, the governor of Burma, permission to obtain two specimens was given the Vernay-Faunthorpe expedition. Mr. H. C. Smith, game warden of Burma, was delegated to accompany the expedition.

Mr. Albert E. Butler and Mr. Clarence S. Rosenkranz of the American Museum staff are accompanying the expedition for the purpose of obtaining accessory material and background studies for the Indian Hall groups.

OTHER MUSEUMS

THE SETTING TO THE HISPANIC MUSEUM at Broadway between 155th and 156th streets, New York City, has been greatly beautified by a magnificent bronze equestrian statue representing El Cid, the favorite hero of Spain. The sculptress is Anna Hyatt Huntington, noted for her statue of Joan of Arc on Riverside Drive, and other excellent pieces.

REPTILES AND AMPHIBIANS

THE SUMMER OF 1927 YIELDS TWO RECORD SIZE LEATHER-BACK TURTLES.—The leather-back turtle *Dermochelys coriacea* (*Linné*) normally inhabits the warmer parts of the Atlantic Ocean, while the only other species, *D. schlegelii* (Garman) is found similarly in the Pacific. Occasionally individuals of the former species wander northward with the Gulf Stream, sometimes being found as far north as Maine. Hardly a summer passes without reports coming to the American Museum of specimens caught off the New York coast. Usually these reports describe huge individuals which, upon investigation, shrink considerably. However, these turtles do grow larger than any other present form.

In July of this year information was received at the Museum of an especially large specimen which had been found in the pound nets off Beach Haven, New Jersey, and which had been purchased by Mr. S. Walling of Keyport, New Jersey. Upon going down to measure the then still living reptile, I found it to be a truly gigantic beast, and so far as available records show, the largest individual ever measured. The total length over the curve of the back was seven feet four inches, while the width over the back, from tip to tip of the pectoral flippers, was eight feet ten inches. The carapace measured, along the curve, five feet seven inches. The turtle was not weighed by itself, but with the truck on which it was loaded, and in this way it was estimated at 1130 lbs.

To have a second turtle nearly as large as the first caught within three weeks thereafter was indeed a surprise. It was harpooned in Fire Island Inlet on the s uthern shore of Long Island by Mr. O. C. Grinnell of Bay Shore, New York, who kindly presented it to the Museum. It is now being prepared as a mounted skeleton. This turtle when received was measured and found to be seven feet one inch in length over the back, and eight feet nine inches across the flippers. The carapace

over the curve was five feet three inches. When weighed on the scales at the Museum, however, it came to only 775 lbs.

Dr. C. H. Townsend, of the New York Aquarium, says in the *Zoological Society Bulletin* for November–December of 1926, that the carapace of a leather-back at the Aquarium measured, over the curve, five feet one inch. It weighed at death 840 lbs., which was after it had been without food for some time. "This," he says, "was thought to be the largest turtle actually weighed in the flesh, until recently the California Academy of Sciences received one that was five feet three inches over the carapace and weighing 1286 lbs." This specimen is the same length as the one being mounted at the American Museum.

Thus, through the courtesy of Mr. Grinnell, the American Museum will be able to display a skeleton of a leather-back turtle which of all those recorded is exceeded in length by only one other specimen, the one found at Beach Harbor, which Mr. Walling kept.—W. G. Hassler.

SCIENCE OF MAN

Field Work under the Ogden Mills Survey.—The object of the field work this summer in the Southwest under the Ogden Mills Survey was to obtain material which might enable us to be in a position to attack the racial problem in the archæology of the Southwest. Physically one of the least known of the cultural strata in the Southwest is the Post Basket Maker period (Basket Maker III). Consequently our primary efforts were directed toward this culture. The actual field work began the first of August with excavation of a large Post Basket Maker refuse mound, about 600 feet long and 300 wide. This site is located at Mitten Rock, west of Ship Rock, in the Navajo Reservation in New Mexico. Although the skeletal material was frequently fragmentary, we obtained a representative collection of crania and skeletons. The pottery was typically Post Basket Maker ware of the gray variety, usually without decoration. The decorated pieces showed crude black designs. Our next site was at Tocito, some 25 miles to the south. Here the culture stratum was Pueblo and we obtained a number of well-preserved skeletons and some excellent black-on-white ware characteristic of this period. The latter half of September was spent at La Plata in the southwestern corner of Colorado, where the Post Basket Maker culture achieved a well-developed stage. We dug in small scattered sites without clearly marked refuse mounds. But fortunately we secured an excellent collection of skeletons and a number of extremely fine vessels showing the developed character of the ware of this area.

Also at La Plata we made an unusual discovery in a small cave. Resting directly on an old fire we found a large corrugated pot of the Pueblo period in which there were the skeletal remains of at least two individuals, including the skull of one. The stratum was undisturbed, and the finding of scattered fragments of human bone leads one to believe that here were the actual remains of some cannibalistic rite.—H. L. Shapiro.

Quetzalcoatl Serpent Head.—Through the generosity of the Famous Players-Lasky Corporation the Museum has recently acquired a large serpent head of stone from the temple of Quetzalcoatl, ruins of San Juan de Teotihuacan, Mexico. This temple is one of the best known and most intersting of the discovered buildings belonging to the Toltec civilization. Thus a carved element of the original façade is a distinct addition through its historic and artistic importance to our Mexican collections. The serpent head was presented by the Mexican Government to the Famous Players-Lasky Corporation and through the courtesy of Mr. O. R. Geyer it was transmitted by that organization to the Museum.

Javanese Drama Collection.—Through the generosity of Mr. George D. Pratt a valuable Javanese collection has been secured. This collection contains forty-two painted wooden masks, with a wide range of individual variation from the placid, highly stylized female masks to the grotesque, tusked masks of monsters and demons. The eighty-seven marionettes represent all the forms used in the traditional Javanese theater,—the delicate silhouettes of buffalo hide rich with gold paint and elaborate filigree work, the flat wooden puppets which represent characters in a less remote period of Javanese history, and a few wooden puppets which are carved in the round. Students of marionettes will be interested in the wide variety of expression and posture which can be obtained in such a highly conventionalized medium, while art students will enjoy seeing such a rich selection of the originals of a favorite design element in Javanese art.

NEW PUBLICATIONS

CENTRAL ASIATIC EXPEDITIONS.—Since September 1 seven *Bulletin* and *Novitates* articles on Asiatic fishes, amphibians and reptiles, mammals, and fossil plants have appeared under the authorships of J. T. Nichols, Clifford Pope, R. W. Chaney, Glover M. Allen, and Karl P. Schmidt. These are in the series of Preliminary Reports of the Asiatic Expeditions which now number seventy-eight. Numbers one to sixty-three have been bound together as Volume I of these Preliminary Reports and there is already an accumulation of about half enough separata for a second volume.

The Geology of Mongolia, by Charles P. Berkey and Frederick K. Morris, has just been printed by the Knickerbocker Press of G. P. Putnam's Sons, New York. As Volume II of the *Natural History of Central Asia*, it is the first of a series of twelve *de luxe* volumes to appear on the work of the Central Asiatic Expeditions of the American Museum of Natural History. The book is a well-balanced and meritorious contribution to knowledge of the geology of a large portion of the Republic of Mongolia. It is of small memoir size, consisting of 475 printed pages and 205 illustrations, ten of them in colors.

Professor Berkey, the senior author, is head of the department of geology of Columbia University, New York; Mr. Morris, the junior author, is at present associated with the department of geology of the Massachusetts Institute of Technology, Cambridge, Massachusetts.

The field studies, which constitute the basis of this contribution, were made during the summers of 1922 and 1923, as part of the program of the Third Asiatic Expedition of the American Museum of Natural History, which Roy Chapman Andrews organized and led. The expedition traversed in motor cars many of the camel trails of inner and outer Mongolia, that is, the trade routes along which caravans have been directed for untold centuries. It is a historic region, for under their famous leader, Ghengis Kahn, 1162 to 1227 A.D., the Mongols ruled two-thirds of Eurasia. Although it is a region of great antiquity, it is a vast desert basin encompassed by high mountains—a wonderful field for the geologist with the rocks well exposed.

In 1922, it was a new land to the scientific world; explorers of various nationalities, particularly the Russians, had crossed various parts of it, but the characteristics of its bed rock and economic potentialities were still unknown. In addition to making a geological reconnaissance of the extensive route traversed, the geologists mapped special areas where the expedition camped a week or more. Maps in color, of six of these special areas appear in the pocket at the end of the volume.

—C. A. REEDS.

Across Asia's Snows and Deserts by William J. Morden, published by G. P. Putnam's Sons (October, 1927), is an account of the journey of the Morden-Clark Asiatic Expedition of the American Museum. The expedition, which was led by Mr. Morden, and included James L. Clark, assistant director of the Museum, went in search of *Ovis poli* and ibex. It was Mr. Morden's theory that *Ovis poli* existed in greater numbers than reports suggested, and the expedition proved that this theory was correct. More than a thousand rams and more than six hundred does were counted, and the expedition obtained a very complete series for the Museum's collection.

After completing the *Ovis poli* hunt in the Russian Pamirs, the expedition continued across Chinese Turkestan to the Thian Shau, and there collected a series of ibex.

It was the purpose of the expedition to continue to Mongolia, there to meet Dr. Roy Chapman Andrews, in order to return with him to Peking. A message received in the heart of Asia, however, announced that Andrews, because of the Chinese revolution, had been unable to carry out his plans. Despite this news, Morden and Clark determined to cross Mongolia, and as winter was approaching, left Kuchengtze, in Turkestan, with a camel caravan. They were captured by the Mongols at the tiny military post of Ji-ji-ho, and during the first forty-eight hours of their captivity were tortured by the soldiers, who had no understanding of their purposes in entering the country, and did not know who or what Americans were.

Ultimately, after being held under armed guard for three weeks, during which time they were taken across hundreds of miles of frozen, snow-covered desert, they were released at the town of Kobdo, and were permitted to make their way for six hundred more miles to a branch of the Trans-Siberian Railroad, by which they made their way to Peking.

The book is handsomely illustrated with sixty-three photographs and three maps, and

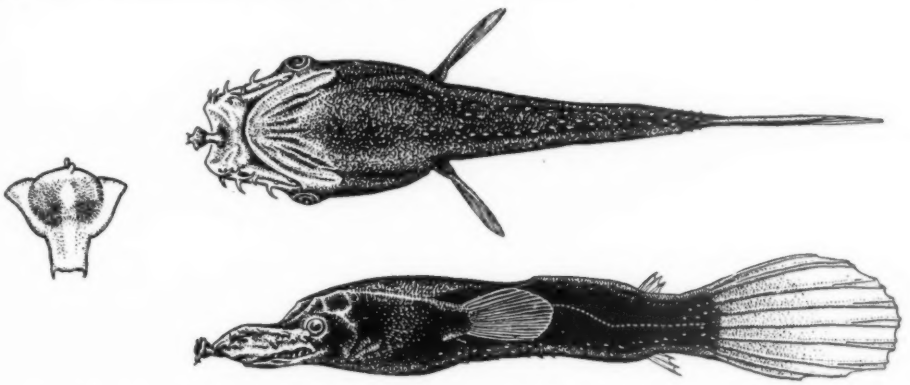
contains a very complete account of this extraordinary journey. Mr. Morden has proved himself to be not only an explorer of ability, but an observer whose description of Central Asia will become an important record of that difficult and little known land.

The Natural Bridge of Virginia and its Environs is the title of a new booklet by Dr. Chester A. Reeds, curator of invertebrate palæonotology in the American Museum.

The booklet, which bears the copyright of the author, contains sixty-four pages and eighty-five illustrations. It has the same format as the well-known *National Geographic* magazine. The booklet was printed in August, 1927, by the Momad Publishing Company Incorporated, of 150 Lafayette Street, New York, and 5000 copies have been placed on sale at the Natural Bridge Hotel, Natural Bridge, Virginia.

In addition to being a guide to Natural Bridge, and the gorge of Cedar Creek, the booklet contains a description and discussion of the origin and development of these striking geographic features. It is interesting to note that although this limestone bridge is the most pronounced curiosity of its kind in America, and has been known since Thomas Jefferson purchased it from King George III, in 1774, no publication on the Natural Bridge has appeared heretofore, which may be compared with this one. Doctor Reeds's able presentation of the subject and wealth of illustrations make it an outstanding booklet. It was written as a companion piece to the one on "The Endless Caverns of the Shenandoah Valley" which appeared in 1925.

BINGHAM OCEANOGRAPHIC COLLECTION.—The first Bulletin of the Bingham Oceanographic Collection to be issued was noted in the last number of NATURAL HISTORY. We now have before us a full report on the fishes obtained during the 1925 cruise of Mr. Bingham's yacht, "The Pawnee," about the Bahamas and in the Caribbean. Some twenty forms are described as new. Of particular interest are a peculiar finned eel (*Anguillichthys*, new genus), *Hepatus pawnee*, and a small aberrant surgeonfish very like one obtained by "The Albatross" in the Pacific some years ago. This bulletin is one of the most important recent contributions to our knowledge of the seemingly inexhaustible variety of fish life in the "Spanish Main."[1]



One of the fishes of the Bingham Oceanographic Collection.—In *Thaumatichthys binghami*, perhaps the most peculiar of the new species of frog-fishes, the upper jaws are attached to the margins of a broad membrane so that they fold around the edges of the lower jaw to close the mouth. The luminous bulb is not, as is usual among these fishes, placed on top of the head, but projects straight forward from the roof of the mouth, a most convenient place for a bait, if that is the nature of the peculiar organ. The eyes are also found in a very unusual position at the angles of the mouth. Only one related species has formerly been known to science

We understand that another bulletin describing rare and new forms of deep-sea crustaceans by Miss Lee Boone is in page proof as this issue of NATURAL HISTORY goes to press.

Dragon Lizards of Komodo, the story of the expedition led by William Douglas Burden to one of the Lesser Sunda Islands in Malaysia, in search of *Varanus komodoensis*, has just appeared from the press.

Reptile Study, a handbook for the study of American reptiles, has been prepared by William G. Hassler of the department of

[1] "Fishes of the Spanish Main," NATURAL HISTORY, Vol. XX, pp. 449–451.

reptiles in the American Museum at the request of Headquarters of the Boy Scouts of America. The handbook is intended to meet the immediate needs of scouts who, in order to win a Merit Badge in this study, must pass certain examinations therein. The book, however, should prove of general interest to any student of reptile life.

THE FOLLOWING PAPERS have been published in *Novitates* and the *Bulletin* during the period from September 6 to November 9, 1927.

Novitates

No. 273.—REMARKS ON THE CLASSIFICATION OF THE PTEROCLIDIDÆ. By W. Wedgwood Bowen. 12 pp. Two text figures. September 6, 1927.

No. 274.—SOME BEES PRINCIPALLY FROM FORMOSA AND CHINA. By T. D. A. Cockerell. 16 pp. September 7, 1927.

No. 275.—FOUR NEW AMERICAN DIPTERA. By C. H. Curran. 4 pp. Three text figures. September 8, 1927.

No. 276.—ON CERTAIN FORMS OF *Puffinus assimilis* AND ITS ALLIES. By Robert Cushman Murphy. 15 pp. September 8, 1927.

No. 277. NOTES ON SOME ANTHIDIINE BEES OF MONTANA AND CALIFORNIA. By Herbert F. Schwarz. 8 pp. September 9, 1927.

No. 278.—A NEW *Ramphocorixa* FROM HAITI. (Hemiptera-Corixidæ). By H. B. Hungerford. 2 pp. Six text figures. September 9, 1927.

No. 279.—A NEW TREE-FROG FROM PORTO RICO. By Karl Patterson Schmidt. 3 pp. September 10, 1927.

No. 280.—UNDESCRIBED OR LITTLE-KNOWN BIRDS FROM PANAMA. By Ludlow Griscom. 19 pp. September 10, 1927.

No. 281.—A NEW BLENNY FROM THE HAWAIIAN ISLANDS. By N. A. Borodin. 2 pp. One text figures. September 12, 1927.

No. 282.—AN ORNITHOLOGICAL RECONNAISSANCE IN EASTERN PANAMA IN 1927. By Ludlow Griscom. 10 pp. September 12, 1927.

No. 283.—HACKBERRY SEEDS FROM THE PLEISTOCENE LOESS OF NORTHERN CHINA. Ry Ralph W. Chaney. 2 pp. Two text figures. September 13, 1927.

No. 284.—LAGOMORPHS COLLECTED BY THE ASIATIC EXPEDITIONS. By Glover M. Allen. 11 pp. September 13, 1927.

No. 285.—A NEW SPECIES OF THE FAMILY TABANIDÆ FROM THE BELGIAN CONGO, WITH NOTES ON THE GENERIC POSITION OF RELATED SPECIES. By James S. Hine. 4 pp. September 28, 1927.

No. 286.—RESULTS OF THE DOUGLAS BURDEN EXPEDITION TO THE ISLAND OF KOMODO. I.—NOTES ON *Varanus komodoensis* By Emmett Reid Dunn. 10 pp. September 30, 1927.

No. 287.—RESULTS OF THE DOUGLAS BURDEN EXPEDITION TO THE ISLAND OF KOMODO. II.—SNAKES FROM THE EAST INDIES. By Emmett Reid Dunn. 7 pp. September 30, 1927.

No. 288.—RESULTS OF THE DOUGLAS BURDEN EXPEDITION TO THE ISLAND OF KOMODO. III.—LIZARDS FROM THE EAST INDIES. By Emmett Reid Dunn. 13 pp. September 30, 1927.

No. 289.—THE SKULL CHARACTERS OF *Crocodilus megarhinus* ANDREWS. By Charles C. Mook. 8 pp. Two text figures. October 10, 1927.

No. 290.—PORCUPINES FROM CHINA. By Glover M. Allen. 4 pp. October 24, 1927.

Bulletin

Bulletin LIV, Art. 1. "The Orthoptera of the West Indies. No. 1. Blattidæ." By James A. G. Rehn and Morgan Hebard. 320 pp. Plates I–XXV. September 9, 1927.

Bulletin LIV, Art. 2. "The Fishes of Hainan.' By John T. Nichols and Clifford H. Pope. 74 pp. Plate XXVI, 51 text figures. September 12, 1927.

Bulletin LVI, Art. 3. "The Reptiles of Hainan." By Karl Patterson Schmidt. (With abstracts from the field notes of Cilfford H. Pope.) 71 pp. Plate XXVII, 17 text figures. October 6, 1927.

Bulletin LVI, Art. 4. "Notes on Chinese Reptiles." By Karl Patterson Schmidt. (With extracts from the field notes of Clifford H. Pope.) 86 pp. Plates XXVIII to XXX, 22 text figures. October 11, 1927.

Bulletin LVI, Art. 5. "Notes on Chinese Amphibians." By Karl Patterson Schmidt. 24 pp. Plates XXXI and XXXII. October 14, 1927.

Bulletin LVII. Art. 1. "On the Anatomy and Classification of the Weaver-Birds." By Peter P. Sushkin. 32 pp. Eighteen text figures. October 24, 1927.

Bulletin LVII. Art. 2. "Diptera of the American Museum Congo Expedition." By C. H. Curran. 57 pp. Two text figures. November 9, 1927.

HONORS

DR. FREDERICK A. LUCAS was elected to honorary membership in the Museums Association of Great Britain, at their recent meeting. This is the first time this distinction has been conferred on anyone outside of Great Britain. Among the Honorary Members are Sir Frederick Kenyon, Sir Sidney Harmer, and Sir Cecil Smith, respectively former directors of the British Museum, British Museum of Natural History, and Victoria and Albert Museum, who were retired when they reached the age limit prescribed by law.

SEVENTIETH ANNIVERSARY CELEBRATION FOR PROFESSOR OSBORN

The beautiful bird hall on the second floor of the American Museum was the setting for the reception tendered Prof. and Mrs. Henry Fairfield Osborn on the evening of September 29, 1927. The occasion was the seventieth anniversary celebration in honor of Professor Osborn's birthday, which was arranged as an expression of esteem and affection by his many friends and colleagues. Addresses were made by Dr. Frank M. Chapman, who presided, Prof. Wm. B. Scott of Princeton, lifelong friend of Professor Osborn, and by Professor Osborn, who paid high tribute to the unfailing inspiration and encouragement from Mrs. Osborn during the forty-six years of their married life.

The silver-gilt Queen Anne cup and the engrossed resolutions containing greetings from hundreds of Professor Osborn's friends from all over the world were on view during the reception.

After the addresses, the distinguished guests had an opportunity to greet and extend their felicitations personally to Professor and Mrs. Osborn.

MEETINGS OF SOCIETIES

BICENTENARY OF THE DEATH OF NEWTON.—Meetings and exhibitions commemorating the Bicentenary of the death of Sir Isaac Newton (1642–1727) will be held in Education Hall, in the School Service Building of the American Museum on November 25 and 26, 1927, at 10 A.M. and 2 P.M. under the auspices of the History of Science Society, in collaboration with the American Astronomical Society, The American Mathematical Society, the American Physical Society, and various other organizations.

Addresses will be given by distinguished scientists and philosophers of the United States and Canada, relating to Newton's interests in the fields of astronomy, mathematics, physics, chemistry, religion, and to his work at the mint.

The exhibition of Newtoniana, including portraits, medals, autograph letters, early editions, and association copies, and of material relating to Newton's predecessors and contemporaries in his fields of major interests, and to his translators, editors, and biographers, will be open daily from November 25 to December 17.

FUERTES MEMORIALIST.—Dr. Frank M. Chapman has been appointed by the president of the Ornithologists Union to act as memorialist for Louis Agassiz Fuertes. An article will appear in *The Auk* and will be presented at the annual meeting of the Union November 15.

THE INTERNATIONAL CONGRESS OF AMERICANISTS is to hold its twenty-third session at the American Museum of Natural History beginning the middle of next September. The Congress meets biennially with alternate sessions in the Old and the New World. The subjects discussed relate to native peoples of America and the historical, geographical, and geological problems related to them. It is expected that many prominent scholars and scientists from Europe, Mexico, and South America will attend. The thirteenth session was also held at the American Museum in 1902.

THE NEW YORK BIRD AND TREE CLUB held its annual meeting in the Members' Room of the American Museum on Thursday, October 27. The following persons were elected to office for the current year: Honorary President, Dr. George F. Kunz; President, Dr. Clyde Fisher; Vice-Presidents, Mrs. Thomas A. Edison, Miss Henriette Ord Jones, Mrs. James R. McKee, Mrs. John Lewis Childs; Recording Secretary, Mrs. T. Carlyle Jones; Corresponding Secretary, Miss M. Louise Rieker; Treasurer, Mrs. Mansfield Merriman.

THE HORTICULTURAL SOCIETY OF NEW YORK held an exhibition of plants and flowers in the American Museum November 10–13. For the second time the large exhibition hall on the first floor of the Scool Service Building staged the display, which ranked well with the high standard established during the past score of years. The giant chrysanthemums were exceptionally beautiful, as were the roses. Exhibits deserving special mention were collections of greenhouse foliage plants, and an

unusually large and fine display of orchids. Most of the plants came from florists and horticulturists within one hundred miles of New York City, but one exhibit that attracted much attention was a large collection of carnations which had been sent from Denver, Colorado, by aëroplane, and which arrived in excellent condition.

ROOSEVELT DAY.—In celebration of Roosevelt Day, October 28, which was officially set apart by Governor Smith, there was placed in the foyer of the American Museum the following exhibit where it could not fail to attract the attention of all visitors who entered the building: a case of books by Roosevelt including all that could be classed as natural history, a snowy owl which had been collected and mounted by Roosevelt in his teens, a bust of Roosevelt by James Earle Fraser, a photographic portrait of Roosevelt, and the architect's model of the proposed Roosevelt memorial. In connection with this celebration, six showings of motion picture films illustrating the life of Roosevelt were held. Two showings were given the day before the birthday for school children, and four on the birthday for the general public. The motion picture films were lent to the Museum for this purpose by the Roosevelt Memorial Association.

AMERICAN MEN OF SCIENCE

DR. J. MCKEEN CATTELL in a recent number of *Science* has presented an analysis of the origin and distribution of the leaders of science appearing in the Fourth Edition of "American Men of Science." The leaders are selected by a vote of their colleagues and the honor which is thus given them is indicated in the directory. It is gratifying that the scientific staff of the American Museum includes a large percentage of the leaders in American science. To quote directly from Doctor Cattell's article, "The past twenty-six years have witnessed the development of endowed research institutions and the Carnegie Institution of Washington now stands next to Harvard and Chicago in the number of its scientific men of distinction. The Rockefeller Institute, limited to medical research, has also attained a high position. In this period the Carnegie Institution has grown from 7 to 47; the Rockefeller Institute from 3 to 19. The Boyce Thompson Institute, the Wistar Institute and the Mayo Clinic also show gains. The American Museum of Natural History and the New York Botanical Garden, with respectively 13 and 8 of the scientific men, rank before most universities and show a gain since 1906. It is of interest that these institutions can flourish under support and control partly private and partly public."

MR. B. T. B. HYDE, more familiarly known to many as "Uncle Benny," has gone to Arizona to regain his health. For five years Mr. Hyde maintained a Nature Corner in the Entomological Hall of the American Museum. Here live snakes, insects, turtles, and creatures representing other branches of Nature Study were to be found. "Uncle Benny" was usually present to welcome visitors, who, wandering through the halls, were attracted by the open railed area where someone was working and where questions were invited.

Much of the work that was formerly carried on there will, in the future, go forward in the School Service Building.

NEW MEMBERS

SINCE the last issue of NATURAL HISTORY, the following persons have been elected members of the American Museum, making the total membership 9880.

Associate Founder

Mr. ARTHUR S. VERNAY.

Patrons

Messrs. MAUNSELL S. CROSBY, S. A. GOLDSCHMIDT.

Life Members

Mesdames: WILLIAM I. BARRY, LOUIS D. CONLEY, JOHN L. GIVEN.

Miss: MARIA BABCOCK.

Messrs: CHARLES E. BEDAUX, HIRAM BLAUVELT, GEO. L. BOURNE, BARRON COLLIER, ROBERT CRABB, WILLIAM T. DEWART, JOSEPH H. EMERY, EDWARD R . H. GRUENEWALD, JAMES H. LOCKHART, ANDRE MERTZANOFF, WM. NESBIT, MORTON J. NEWBURGER, REUBEN D. SILLIMAN.

Sustaining Members

Mesdames: CHARLES E. BEDAUX, C. K. G. BILLINGS, H. CASIMIR DE RHAM.

Miss: NINA RHOADES.

Doctor: ALBERT A. BERG.

Messrs: SIDNEY J. BAUMANN, PAUL BLOCK, EDWARD I. FARMER, FRANK I. LIVERIGHT, ALLAN MCCULLOH.

Annual Members

Mesdames: Ellice M. Alger, Charles T. Barney, Joseph Black, T. Whitney Blake, L. W. Bonney, Samuel Brill, William Edward Cassell, L. W. Cole, H. A. Cushing, Robert C. Ferguson, Gertrude K. Finch, Robert M. Frank, A. R. Geissler, Malcolm Gifford, Henry M. Hewitt, L. Emmett Holt, Frederick Morgan Johnson, Mary Alice Barney Kean, John Henry Livingston, Max Mayer, Donald McGraw, W. Bard McVickar, J. Blackburn Miller, Charles E. Milmine, Paul Morton, Sarah Neely Murphy, James O'Neill, Grace V. C. Schley, Albert B. Schultz, Marguerite E. Schwarzmann, Kenneth A. Stier.

Sister: M. Adrian.

Misses: Ina Clayton Atwood, Jennie Mae Clark, Gladys M. Craig, Louise Eltinge, Helen Frank, May Hardart, Nina D. Herzog, Esther S. Hotchkiss, Helena A. Hulskamp, Lucile Renèe Koch, Margaret Bispham Levey, Helen M. Metzner, Susanne Meyer, Elizabeth Purcell, Alice R. Wilson.

Doctors: Raymonde A. Albray, Thaddeus Hoyt Ames, Cameron Vernon Bailey, Edgar M. Bick, Theodor Blum, Charles W. Burr, H. C. Fleming, Melvin Randolph Gilmore, Geo. C. McBride, A. L. Melander, M. Oshima, Sidney N. Parkinson, Arnold Peskind, Hervey C. Williamson.

Messrs: Theodore Badman, Wm. T. Baird, Louis G. Banker, William R. Beal, Lucius H. Biglow, Homer S. Black, Frederick W. Bohlmeyer, Frank Bohn, Edward Bose, Alfred Lockwood Brown, Edmund Brown, Jr., R. R. Brown, F. A. Burghardt, C. Alexander Capron, R. P. Clayberger, Paul L. Depland, Wilson D. I. Domer, Charles S. Doran, Louis Dreifuss, Arthur F. Elliott, Reginald S. Evans, W. T. Farley, W. Edward Foster, I. C. Gary, Simone N. Gazan, Lafayette A. Goldstone, Abner Graff, Arthur Butler Graham, William Graupner, Abraham L. Gutman, Harry Peale Haldt, Louis Hammer, Bernard J. Harrison, Isaac Harter, Rowland Hazard, John A. Hird, Lester Hofheimer, Frederick T. Holmes, Charles W. Holton, Harley D. Hutchins, Percy R. Iseman, Emanuel Jacob, Julius M. Johnson, Robcliff V. Jones, H. Thorn King, Jr., Joseph Klaw, Alfred-Kohlberg, W. S. Lambie, Antonio Lazo, Max J. Levy, Walter L. Lipman, John W. Little, M. H. Lynch, Harry Mack, Paul Maddaus, Albert Mayer, Lawrence S. Mayers, Walter M. McGee, Philip Gurdon Mumford, Royden L. Nathan, Robert T. Neely, S. Van B. Nichols, Fayette S. Olmsted, Lester Osborne, Frederick W. Patterson, C. Pelican, John O. Prescott, Joseph M. Price, Peter Rinelli, Thos. F. Russell, Jr., J. B. Salterini, Robert Schey, Gerald Sparks, Charles B. Straus, Malcolm Toch, Henry H. Tryon, Charles N. Waterman, Frederick Weber, Henry Nicoll Wightman, Charles Axford Wood.

Associate Members

Mesdames: G. Bump, Howard Constable, Vincent W. Lanfear, George McDonald, J. Arthur Pilkington, Julian S. Stein.

Misses: Ellen Bullard, Genevieve Burdick, Frances Ernst, Dorothy A. Johnson, Margaret Reinherr, Irma Schmincke, Sarah Lois Staples, Mary Tucker.

Reverend: Geo. H. Richardson.

Professors: John M. Berdan, Frank Wilson Blackmar, R. Borcea, Edward Channing, George C. Engerrand.

Doctors: G. Mason Astley, Joseph C. Aub, H. W. Brinkmann, H. Morton Cameron, Henry Herbert Goddard, C. Hartshorne, A. Pringle Jameson, S. R. Light, Henry D. Lloyd, W. L. Moss, James Morris Page, Edwin B. Powers, D. W. Rife, Denman W. Ross, Frederick A. Saunders, Taylor Starck, Glanville Terrell.

Lieutenant Commander C. H. Dench.

Messrs: Lewis F. Acker, R. P. Boas, Jr., Arthur Cole, Jr., Charles J. Dunn, Robert L. Eastman, Luis F. Estrada, F. L. Ford, Walter Godchaux, Jr., G. H. Heineman, Robert E. S. Heinemann, Arthur W. Henn, Geo. A. Herzog, Francis Welles Hunnewell, Clifton H. Kroll, William C. Lane, J. Eugene Law, J. B. Levison, Oscar M. Longnecker, Jr., Edward John McCarthy, H. W. Mossman, Raymond E. Murphy, Ben Olson, E. D. Patterson, Roland Case Ross, William B. Sharp, L. M. Stubner, C. Newbold Taylor, Richard W. Thatcher, Frank Webber, A. I. V. Wilson.

AFRICAN NUMBER

NOVEMBER-DECEMBER

Carl Akeley's keen desire to preserve for all time a record of the wonderful wild life of Africa crystallized itself into the vision of the African Hall. A glimpse of the magnitude of this vision will be given the reader of the African Number of **Natural History**. The beauty of Africa's flora, the mystery of its jungles, the variety and abundance of its animals, the grandeur of its scenery, the customs of its natives,—all this is described in the following articles:

"The Vanishing Wild Life of Africa" by Henry Fairfield Osborn, "In the Land of His Dreams" by Mary L. Jobe Akeley, "A Safari in Africa" by George Eastman, "Picturing Africa" by Martin Johnson, "Home on Safari" by Osa Johnson, "Adventure Land" by Philip Percival, "Painting the Backgrounds for the Akeley African Hall Groups" by W. R. Leigh, "Natives of East Africa" by A. A. Jansson, "Collecting Large Mammals for Museum Exhibition" by R. H. Rockwell, "Angola as a Game Country" by Arthur S. Vernay, "With the Fuzzies After Ibex" by H. E. Anthony, and "Ruwenzori from the West" by James P. Chapin.

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